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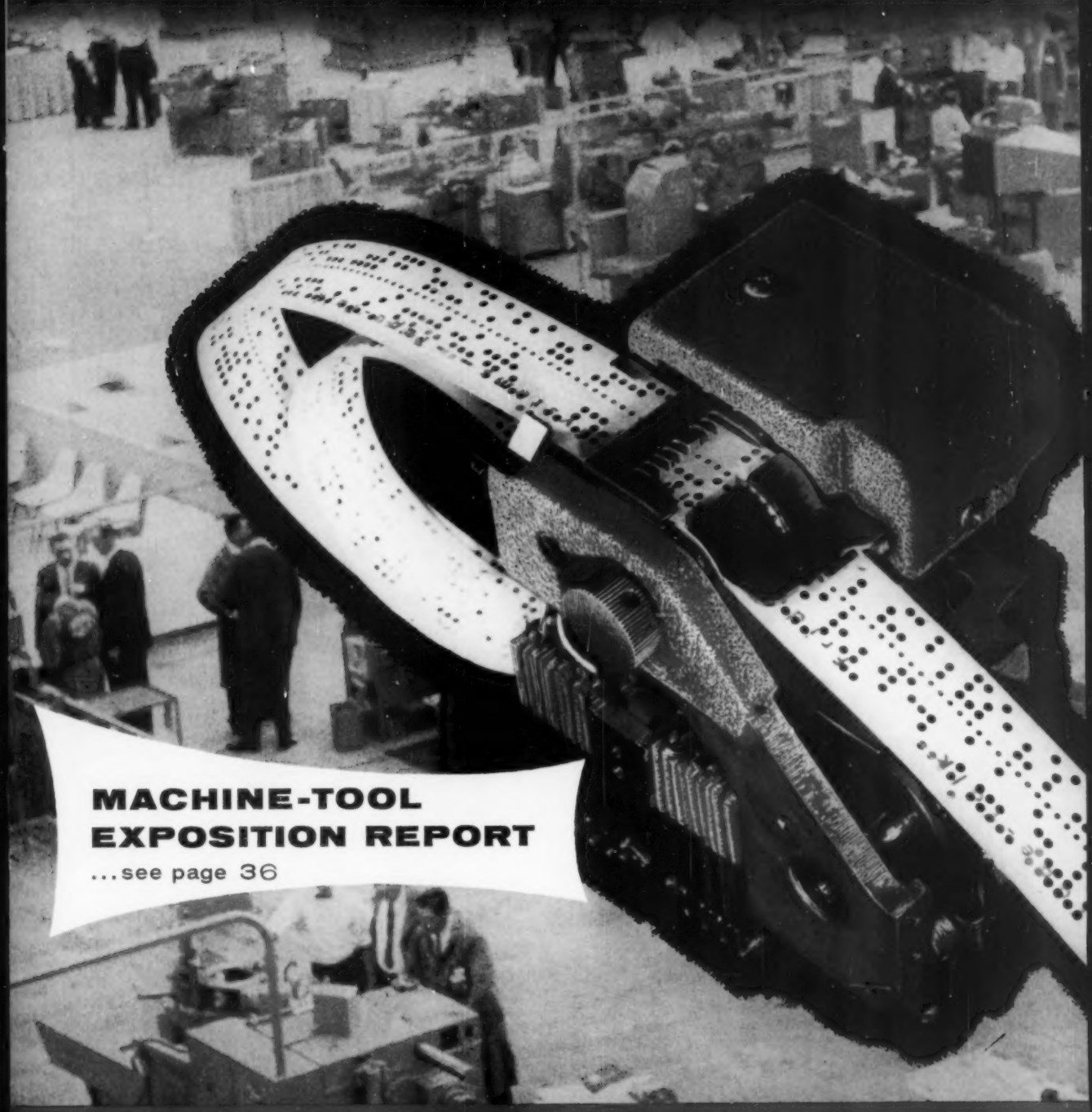
PRODUCT ENGINEERING

McGRAW-HILL WEEKLY OF DESIGN, RESEARCH AND DEVELOPMENT · SEPTEMBER 26, 1960



MACHINE-TOOL EXPOSITION REPORT

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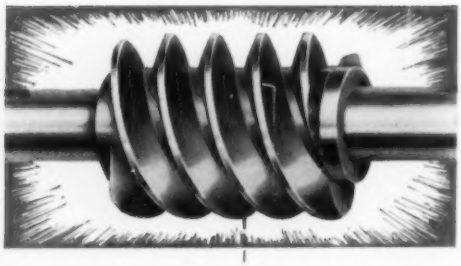

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PRODUCT ENGINEERING

McGRAW-HILL WEEKLY OF DESIGN, RESEARCH AND DEVELOPMENT

September 26, 1960 Vol. 31, No. 40

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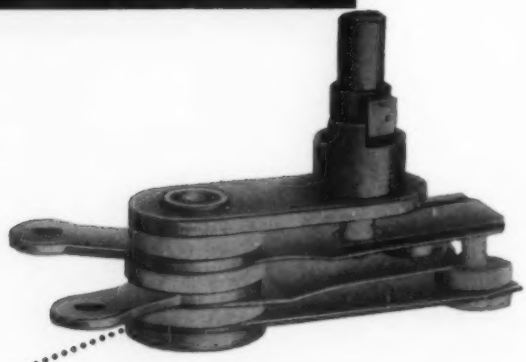

Type S above; Type H below. Other designs available.

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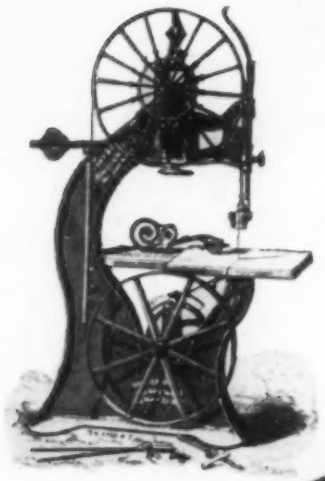
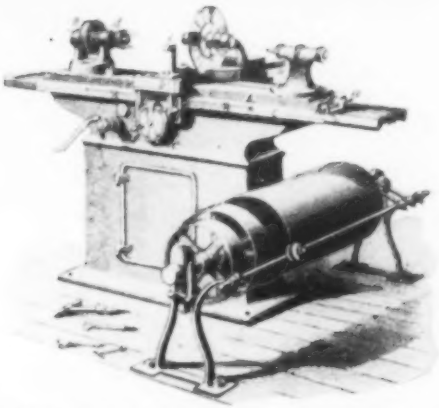
Other appliances, too, **such as percolators, inhalers, air heaters, fans, steam and flat irons, roasters, fry kettles, refrigerators, butter warmers, waffle irons, electronic and avionic applications.**

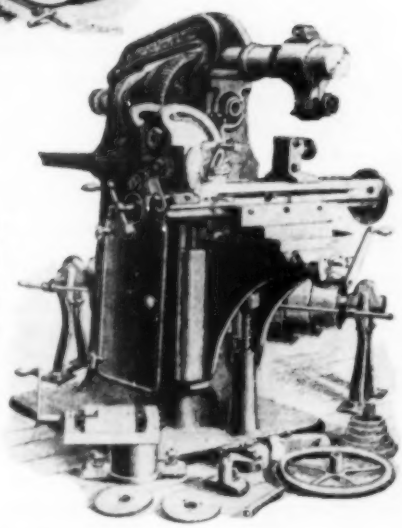
INTERESTING TO NOTE



Band saw created a new era in American architecture called "American Carpentry Renaissance."



Universal grinder aided immeasurably in the new "mass production" concept just getting underway.



Universal milling machine built by Browne and Sharpe Mfg Co., developed just prior to the Centennial.

Machine Tools—Now and Then

Every five years, members of the National Machine Tool Builders' Assn gather in Chicago to display their wares. This year one of the largest crowds in the show's history tramped the floors of the International Amphitheater for a week and a half. PRODUCT ENGINEERING's delegation of editors reports on the show, page 36.

One of the world's greatest displays of machine tools took place at the famous Centennial Exhibition of 1876 in Philadelphia. The show itself was a thing of splendor. The Main Hall was then the world's largest building—exhibits from all over the world included a portion of the

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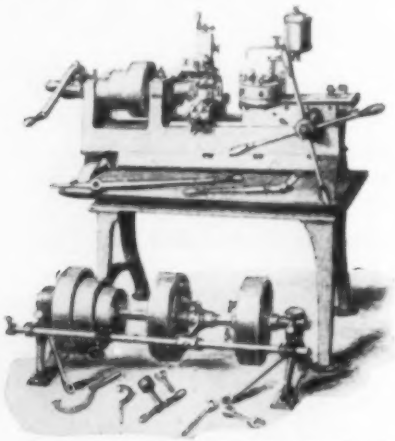
Statue of Liberty from France, a giant steam hammer from England, huge guns from Germany's Krupp Works, a model of an oil well from the United States. However, one of America's most impressive exhibits was its machine tools—steam hammers, guns, or oil wells could never have been built without these.

The Industrial Revolution had long past; the byproducts of the steam age had given England a clear head-start towards an industrial society. Now the United States was showing the world what it could do. Using the basic designs of English inventor Henry Maudslay, Americans added refinement upon refinement until a new and different tool emerged. Shown below and on the preceding page are some of America's machine tools exhibited in Philadelphia three-quarters of a century ago:



Turret lathe developed in America by Robbins and Laurence of Windsor Vt, after Maudslay's earlier design.

One Sun—Many Times

As the railroads pushed westward they discovered one serious problem—every hamlet had its own time standard, based on the sun. Trying to adopt a schedule that would make sense was almost impossible. In 1880, for example, there were more than 50 different "times" in use by the various railroads. A traveler going from Maine to California had to change his watch some 20 times during the journey. In the Buffalo railroad station there were three clocks—one, New York Central Railroad time; another, Lake Shore and Michigan Southern Railroad time; the third, local time. Pittsburgh had six time standards.

In Kansas City the situation was so bad that a professor from Washington University, J. S. Pritchett, was called upon to solve the dilemma. At his suggestion the city built a giant time ball. At noon every day the ball was dropped from a tower and everybody set their watches. Before it was built, scientists wrote papers about the best diameter for the ball, its weight, the height of the mast, and whether the ball should begin or end its fall at noon.

In 1867, school principal Charles F. Dowd of Saratoga Springs, NY advocated four time belts in every 15 degrees of longitude. It took 16 years to convince the railroads to adopt this new method, but at a general time convention in 1883, a resolution to accept Dowd's system was passed.

Convincing the public to accept the railroad's time system was not always easy. One local character said, "Damn old Vanderbilt's time. The Vanderbilts cannot run me even if they do run the rest of the country." The mayor of Bangor, Me refused to recognize the new time, calling it unconstitutional. In general, however, the public quickly accepted the system. Another practical change in the way we measure time is the use of decimal equivalents of minutes and seconds. A quick-reference chart on p 59 simplifies conversions. —Benedict A Leerburger Jr

NEXT WEEK IN PRODUCT ENGINEERING

. . . **Quick-connect Couplings Cut Costs**

For hydraulic and pneumatic systems these plug-ins have a tight joint you can make or break in a hurry.

. . . **Mechanized Tutors Join the Teaching Profession**

Progress report on mechanical, electronic and optical equipment that offers a speedup in training methods.

. . . **Selecting the Right Gasket Material**

This 4-step procedure puts design emphasis where it belongs—on the total bolt force applied to the joint at time of installation.

. . . **Moments in Circular Plates**

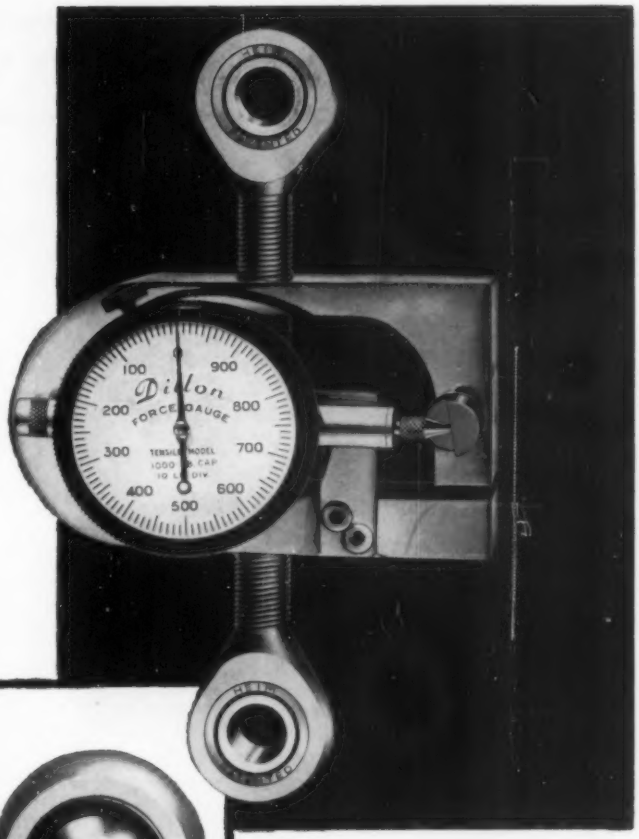
With these tables and equations, you can calculate bending moments at any point in a circular plate.

. . . **Best Illumination for Instrument Dials**

How to provide it by floodlighting, translucence—or by the new method, electroluminescence.

This Success is No Secret...

The Dillon Mechanical Force Gauge is used for precision measurement of pressure, tensile or torque. For ease in applying load to tensile models, Unibal rod end bearings are attached to each leg of the alloy steel bar. If an oscillating, push-pull motion must be measured, both the compressive load and the tensile load are applied through Unibal rod ends.



Heim Unibal Male Rod End

In this case, an instrument calibrated 180 degrees in compression (reading clockwise), and 180 degrees in tensile (reading counterclockwise) is required.

Here is a true success story of a device, built with watchmaker's precision, which is designed to check all such loads, even in limited space.

It is no secret that the

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contributes to the successful operation of the Dillon Force Gauge. Two Unibal male-threaded rod ends are attached to the pressure bar. Calibration in both tensile and compression is conducted against a pin placed through the Unibal, or eye, of the rod end.

Heim Unibal corrects misalignment in every direction, reduces friction, carries maximum loads, saves time and money in assembly.

All Heim bearings are available through the leading bearing distributors in the U. S. and Canada. Send for complete catalog with distributors' names and locations.

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DEVELOPMENTS TO WATCH . . .

New low-cost resins for coatings and molded parts

Flame-cured coatings and new molding compounds are promised by Enjay Chemical as it introduces a new line of butadiene-styrene polymers featuring a wide range of curing properties.

The new *Buton* resins may be cured under conditions varying from a "few minutes at room temperature to a few seconds at flame heat." Flame-curing actually enhances the properties of the resins rather than degrading them, says Enjay. Furthermore, the company claims, these new materials cost less than resins offering comparable chemical and solvent resistance and electrical properties. The resins are now being supplied to coating formulators, and molding applications are under test.

Silicone lubes readied for 600-F service

Silicone oils can be stabilized by addition of cerium soaps, Naval Research Lab reports, increasing their useful life at temperatures to 600 F by factor of 30 to 500.

Reporting on the second phase of its search for lubricants capable of operation from −100 to 600 F, NRL says cerium-stabilized silicones show special promise for applications in which thin films of oil are exposed to air at high temperature.

A report on the first phase of the work (covering stabilizers for use at temperatures to 500 F) has already been published (*PE—July 25, p 6*) and is available through OTS, Dept of Commerce, Washington, DC. The second part is being readied for publication, will be available from the same source—as PB 161449.

(Note: For other reports on Navy research in this field, see *PE—Feb 2 '59, p 14*)

Straighter strip coming from England

A machine that relieves internal stresses in rolled strip so that it is possible to slit the strip in rotary shearing machines without encountering edge-bowing has been developed by British Non Ferrous Metals Assn. What the machine does is apply continuous tension to the strip by passing it over a series of small, staggered rolls. This equalizes the locked-in stresses and prevents buckling when the strip is cut. Size and spacing of the rolls are the critical factors. But the machine is so designed that these can be adjusted to suit the type and thickness of strip.

The machine is being patented and plans have been made for commercial production by two British companies. A technical paper on the machine is also in preparation and should be available shortly.

Midget flow-controller uses fluid's power

A self-acting flow controller for very small pipe has been designed by G A Platon Ltd of Croydon, England.

It can be adapted to handle gas flow from 0.1 to 50 cu ft/hr, or liquids from 1 to 20 gal./hr. In the standard unit, the port has a maximum ID of $\frac{1}{8}$ in. No outside power is required to operate the unit, it's powered by pressure of the fluid itself. It requires only about 1 psi; but, for satisfactory operation, a maximum fluid pressure of 2 to 3 psi should be maintained.

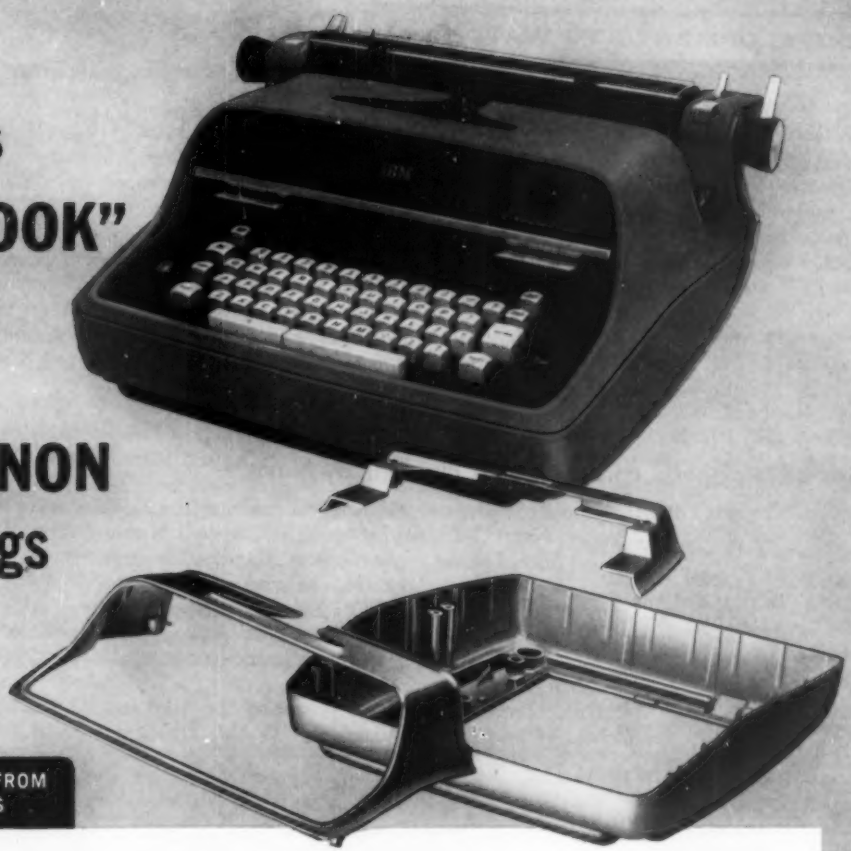
Unlike its larger relatives, which have double-beat poppet valves, the "Flostat Minor" has a single beat valve. Small size of the unit, Platon says, makes "droop" correction unnecessary.

The baby unit also features an unusual leaf spring-and-valve design. The springs, of beryllium copper, are attached to the body of the unit and serve to guide the valve stem. The diaphragm, which serves as a pressure-sensor and moves the springs, may be of synthetic rubber or fluorocarbon plastic. Gold-plated springs can also be supplied for handling fluids corrosive to brass.

Prices are in the $15 to $40 range (US equivalent).

continued on p 8

IBM's "NEW LOOK" enhanced with MT. VERNON Die Castings



CASE HISTORIES FROM MT. VERNON FILES

Behind the sleek silhouette of the dramatically new IBM electric typewriters is "more than a quarter of a century of experience . . . a combination of styling and engineering advances" that promise — and deliver — better performance and easier typing.

For its enclosure IBM knew what it wanted: a new high in eye-pleasing design combined with the many low cost, production benefits of die-casting. It was only natural that, for these die castings, once again, they turned to Mt. Vernon, a reliable supplier to IBM for over 25 years.

And, once again, they found Mt. Vernon's coordinated four-fold service — designing, die making, casting, and machining—equal to the job of meeting their strict requirements: strong, gracefully arched, thin-walled, large aluminum sections that match and fit perfectly. The three castings that cradle and enclose the intricate typewriter mechanism are delivered completely machined, ready for finishing.

Like IBM, leading manufacturers in all industries know and rely on Mt. Vernon's experienced use of its complete facilities for die cast zinc and aluminum parts ready for assembly. These services, all under one roof in 200,000 square feet of space, may hold the answer to your design and production problems. Think about it . . . and let us know. We'll gladly talk it over, without obligation. Just call your nearest Mt. Vernon sales representative.

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Zirconium bearings to operate without grease

Corrosion-free, gall-resistant zirconium bearings that are dimensionally stable and can be used in high-temperature water and steam are claimed by a Canadian nuclear engineer.

The secret of success is formation, by controlled oxidation, of a blue-black zirconium dioxide surface layer on the bearing body. The treatment can be accomplished by exposing the bearings to air, oxygen, steam, or hot water, at temperatures from 1300 to 1650 F.

The process, and its use in journal bearings, has been patented, and is being made available through Canadian Patents & Developments Ltd, National Research Building. Sussex Drive, Ottawa. The CPDL number: 2522.

Improved magnetic core material claimed by Navy

Smaller, more compact core elements for medium- and high-frequency applications can be designed, Naval Ordnance Lab scientists say, by fabricating them of insulated magnetic flakes instead of the conventional nickel-iron alloy powders.

Because the magnetic flakes, in a layered structure, provide fewer airgaps in the direction of the magnetic flux, a higher magnetic permeability is achieved with lower or equally low eddy-current losses. Magnetic-flake cores have been built that are capable of covering the same frequency range as comparable powder cores but show a 100% increase in permeability.

A patent covering processes for producing the flake and fabricating the cores has been obtained by Edmond Adams and W. M. Hubbard of NOL.

Lower costs for beryllium?

Beryllium's commercial price is $70/lb. But it has been produced in government contract plants for $48 to $60 (*PE*—Mar 17 '58, p 66). Is there a chance that this differential will be reduced? And, equally important, will new fabrication methods help to bring down the still-astronomical production costs that make even simple parts worth $125/lb or more? There is evidence now that there is, as witness these recent events:

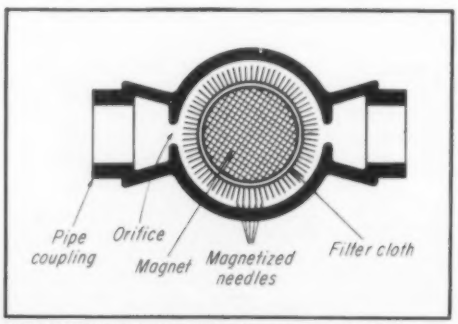
Price extras on rod stock have been reduced 5%.

Powder metallurgy techniques are being improved, and powder costs less than ingot and rod—$64 to $68/lb.

New prospecting methods and instruments like the "berylometer" promise to open new sources of supply, and new government-assistance programs (extension of loan agreements to cover exploration for beryllium minerals other than beryl) are encouraging the hunt.

Fine-particle filter features dual action

A drum-type microfilter designed in Germany uses a cylindrical magnet and a corona of steel needles to catch particles not normally stopped by standard filter materials. Developed by Stelzner & Co, Essen, it can be built in sizes to handle flow rates from 5 to 2600 gal./min. Pressure loss in the unit is said to be unusually low, permitting its installation in suction lines. There is no US representative; but full technical data (in German) may be obtained by writing directly to the company. —ARG



MAGNETIZED NEEDLES catch ultrafine particles in dual-action filter designed in Germany. Cloth filter, wrapped around magnet, catches larger particles. Restricted orifice also helps to improve filtration activity.

WHAT'S HAPPENING IN RESEARCH . . .

Gas lubricants and bearings tested for 1000 to 1400 F

A fluorinated gas that provides good protection for alumina and chrome-alumina bearings, and a brominated gas that's an effective lubricant for nickel-bonded carbides and high-nickel alloys, are described in a recent NASA report.

Researchers at NASA's Lewis Research Center have tested combinations of gases and bearing materials in an attempt to find the "best" combinations for the 1000-F to 1400-F range.

In general, halogenated ethane gave better results than methane gases—the former are less reactive, less likely to induce corrosion.

Test data giving coefficients of friction for the various bearing materials sliding on Stellite disks are contained in a report (TN D-302) prepared by D. H. Buckley and R. L. Johnson of LRC.

(Note: for more on gas lubrication, see *PE*—Nov 23 '59, p 68.)

Tests confirm thermal data on glass

Tests of six types of glass at Battelle Memorial Institute, using half a dozen test techniques, show good agreement between literature and test values for mean linear expansion and density.

Some discrepancies were found in thermal conductivity–notably in the case of fused silica–but these were mainly at higher temperatures. At 932 F, for instance, Battelle obtained a figure of 1.28 btu/hr/ft²/ft/°F. The previous figure was 0.94.

The results and the test methods are contained in a report prepared for publication by the American Ceramic Society.

British report on titanium brazes

Silver-aluminum alloys produce satisfactory joints in titanium and its commercial alloys, the Royal Aircraft Establishment reports, and can be applied without flux at 1200 F in vacuum or argon. Tensile tests of T-shape specimens at room temperature showed strengths of 1250 to 1550 lb per inch run of joint; while end-compression tests of brazed joints in honeycomb sandwich panels show failing stresses on the order of 55 tons/sq in.

The brazing alloy tested was 70% Al–30% Ag. It provided only fair ductility and the brazed joints showed a tendency to corrode in sea water, so ternary and quaternary alloys with silicon, copper, nickel, manganese and titanium itself were tested. Of these, only the nickel and manganese additions seemed helpful, and the increase in ductility was not great.

A copy of the report, MET 95, by H. C. Davis of the Royal Aircraft Establishment, may be obtained on loan from Technical Information Div (Code BID) NASA, Washington 25, DC. The NASA number is N-73873.

briefs . . .

New melting-point determinations for the metals osmium and ruthenium show one has a considerably higher melting point, the other considerably lower than previously reported. Investigations at the Research Laboratory of Associated Electrical Industries Ltd indicate osmium's melting point is close to 5450 F–about 550 deg F more than the generally accepted figure; while ruthenium melts at 4100 F, about 150 deg F below previous determinations. Hardness tests showed wide variations–apparently owing to differences in grain orientation. Room-temperature determinations on ruthenium ranged from 200 to 500 (Vickers); and on osmium from 300 to 670. At 2200 F, the hardness range for ruthenium was 40 to 170; for osmium, a range of 220 to 410, with a mean value of 300, was obtained. This, says J. D. Baird of AEI, seems to be "considerably higher than any other metal at this temperature."

Load-cell calibration on a grand scale is promised by Baldwin-Lima-Hamilton as it starts construction of a new testing facility at Waltham, Mass. BLH says it will have "unique load-generating equipment" that will provide a primary standard for measuring applied loads in tension or compression from 0 to 250,000 lb (present limit–110,000 lb) with an accuracy of ±0.01% of load. "Only accuracy of electrical readout instrumentation will govern the ultimate limit of precision," BHL says. The new testing equipment is expected to be installed and in full operation early next year.

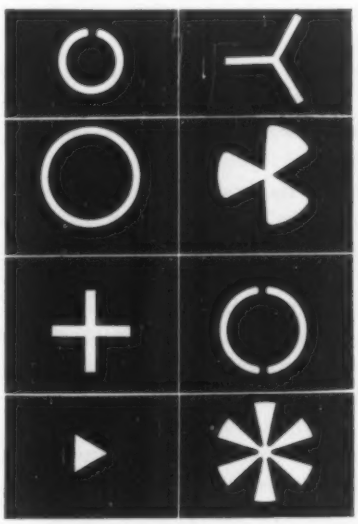
—ARG

New shapes for new fibers

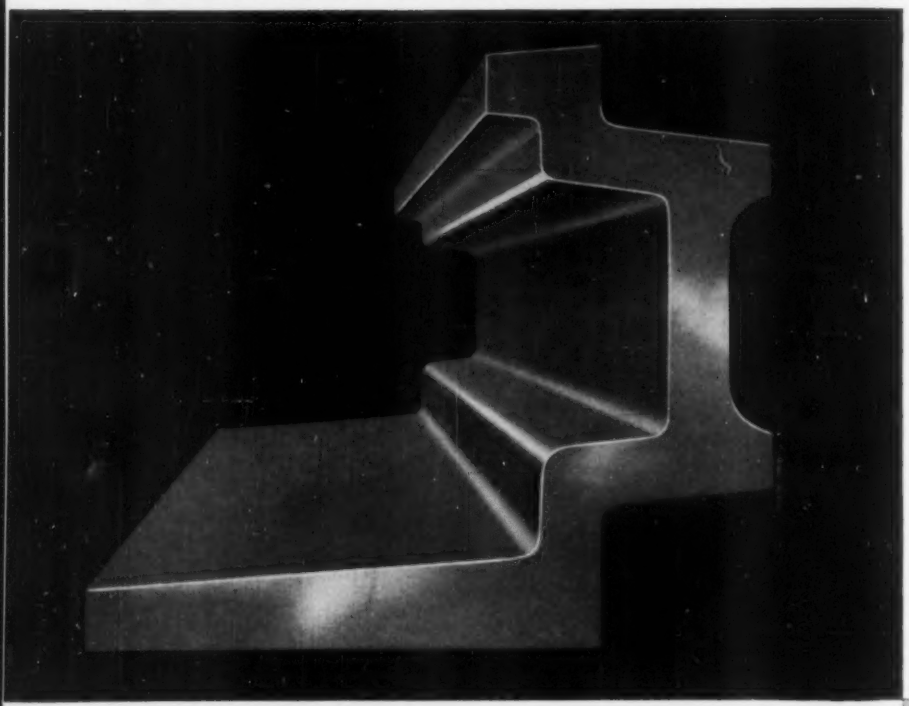
The unusual cross-sections pictured here are not warning signs or hieroglyphic symbols, but samples of new spinning jets that may make it possible to produce fibers with greater wear resistance, higher bulk, and other engineered properties. Johnson, Matthey of England has developed a technique for making these shapes in stainless and heat-resisting steels to permit extrusion of synthetic fibers in radically different forms.

The spinnerettes are now under test by several British manufacturers.

One problem: a good many factors (solution type, extrusion speed) influence final shape of the fibers. They don't always end up with a cross-section that matches that of the jet.



STEEL SHAPED TO CUT COSTS AND IMPROVE PRODUCTS



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Steel window made at low cost with USS Special Rolled Sections.

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Hope's Windows, Inc., makes top-quality, corrosion-resistant steel windows for factory and commercial use. They use many intricate USS Special Rolled Steel Sections that would be too expensive to make by any other method. The unique design of these sections permits them to be used in conjunction with standard shaped sections and has been a significant contributor to profit margins.

Better parts, at lower cost. Better, stronger parts can be produced at substantially lower costs when you use USS Special Sections. When steel is rolled to the cross-section needed, you get a custom-tailored part, designed and rolled so that there is little or no finishing required to meet final specifications.

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REPORT FROM ABROAD . . .

Common Market may bring Europe-wide recognition of engineers

The first halting move toward free circulation of engineers in the six-nation European Common Market area has been made. **The Common Market Commission, acting on a suggestion by the European Federation of National Associations of Engineers (FEANI), has asked for a list of schools in each country entitled to grant recognized engineering diplomas.** Mutual recognition of degrees would be a first step toward free circulation of engineers, although the reality of French, Belgian, Dutch and German engineers working side by side in an Italian plant, for example, is a long way off.

An official of FEANI in Paris thinks the recognition process should be carried two steps further. **First, he thinks, a register of engineers for the Common Market countries should be set up along lines of the one now in Switzerland.** The Swiss register recognizes three classes—engineers, architects and technicians. Bulk of the register is graduates of the two Swiss Polytechnic schools, but others can make the register by passing examinations before a board of experts. Once the Common Market register is established, the FEANI official thinks it could be extended to the other European countries.

Benelux to get world's largest radiotelescope

England's reliable radiotelescope at Jodrell Bank, used both by US and USSR scientists to keep track of their space missiles, may soon be out of work.

The Organization for European Economic Cooperation (OEEC) recently granted $12,000 toward preliminary studies for a new-design radiotelescope to be erected somewhere in the Benelux economic area. Though the site is not yet settled, it is believed that high terrain around Luxembourg will be chosen.

To receive signals from distant galaxies with a high degree of precision, **Benelux "star-gazer" will utilize a cruciform antenna whose arms will be almost 2 mi long and more than 95 ft wide.** This unusual design is said to beat the conventional "bowl" type of antenna—which could not be constructed big enough to meet highly exacting scientific demands. Scientists from the US, Great Britain, Australia and Germany have been invited to participate in the preliminary work.

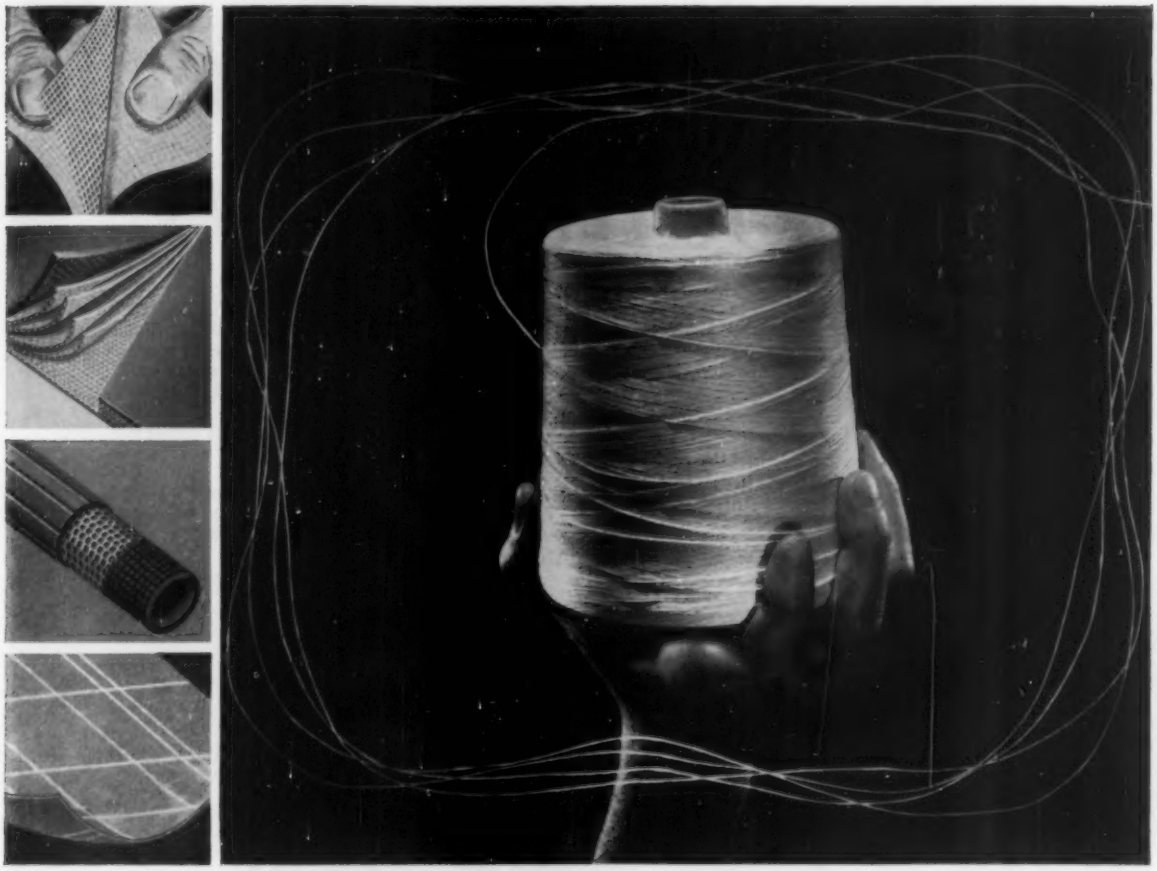
Swiss crack down on dangers from electrical devices

According to a decree of the Swiss Federal Council in Zurich, all electrical equipment whose use can endanger persons or property, or cause radio interference, will have to pass a prescribed safety test and bear the Swiss safety mark. Tests are laid down in safety rules of the Swiss Electrotechnical Institution, Zurich.

Since most electrical appliances and equipment fall into this category, Swiss authorities are taking these steps to guarantee enforcement. No electrical appliances and equipment in the category will be allowed to enter the Swiss market unless bearing the safety mark or the officially recognized quality mark of the Swiss Electrotechnical Institution. For Swiss products, the manufacturer is responsible for any violation. **For imported products, the responsible person is the importer or the manufacturer's agent.** Unaffected by the decree are items using less than 50 v, and equipment designed solely for specialist use.

Examples of products which fall under this decree: Electric razors, mixers, washing machines—and electronic equipment for general use.

An example of Avisco Rayons in Industry



Here's how industry adds muscle to reinforced paper, plastics and rubber.

There are many uses for laminated paper, plastics and rubber which require the addition of a high tensile reinforcement. One of the best is also one of the cheapest: Rayflex high strength filament. You'd pay 22% to 100% more for other fibers with comparable strength, impact and flex life.

Rayflex is the foundation for hose and belting, the basis of packaging tapes, the ideal filament for scrim fabrics that give paper, plastic and foil the economical extra strength they need in laminated constructions.

Avisco rayon can be engineered to meet specific reinforcing needs. Fabricators and users of products that require reinforcement have found that it pays to consult us. We'll be glad to study your problems.

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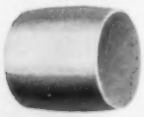

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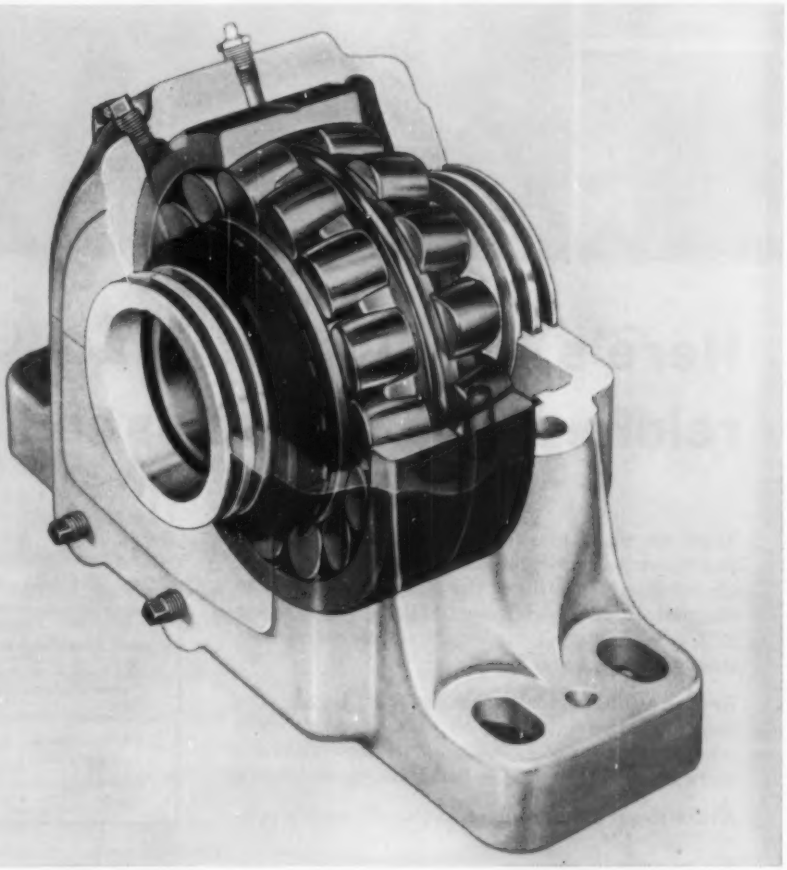

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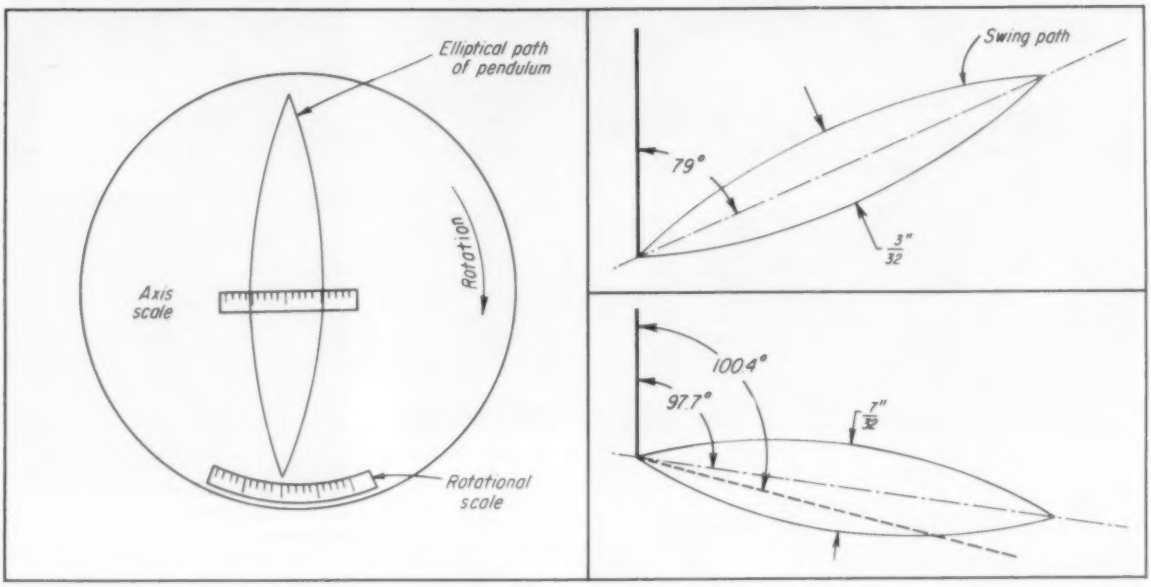


TEST APPARATUS (left) at Griffith Observatory shows pendulum path and measuring scales. Pendulum swings in a 4-ft-deep pit enclosure. Normal pendulum path prior to eclipse is shown (upper right) at 9:35 pm. Deviations from normal path are indicated (lower right) at 12:11 pm. Dashed lines indicate position of transverse axis if rotation had progressed at normal rate.

Pendulum Tests Mystery of Gravity During Lunar Eclipse

Los Angeles—The abnormal behavior of a pendulum at Griffith Observatory here six months ago has been put through mathematical calculations. And the final answer is an enigmatic take-your-choice: This may, or may not be, a sizable breakthrough toward solving the mystery of gravity.

One more possible result of the experiment conducted during an eclipse of the moon is that it may have cast some light on whatever difference there may be between scientist and engineer. The test was conducted by a two-man team—Leon Halls, of the observatory staff, and W. C. Robinette, a consulting engineer. Halls attributes the pendulum deviation to an unknown "scientific phenomenon." Robinette, on the other hand, feels that the present concept of gravity should be abandoned in favor of a new concept.

Their instrument was a Foucault pendulum. This device, developed in 1851, demonstrates the fact of the earth's rotation. The swing of this pendulum is not subject to the earth's rotational force; it swings continuously in a fixed plane while the earth rotates. True, it appears as if the swing path is changing continuously throughout a 24-hour day. Actually, the pendulum follows its same path while the earth revolves once.

With this pendulum, Halls and Robinette tried to duplicate a series of experiments done by a French scientist, Maurice Allias, in 1954. He noticed substantial deviations from the usual motion of the Foucault pendulum during a solar eclipse, and postulated that some as yet unexplained gravity field was responsible.

The Los Angeles attempt to reproduce this effect took place last March 12, during a lunar eclipse. The pendulum was a 240-lb bronze sphere, suspended from a 40-ft wire and attached to a support unaffected by the earth's rotation.

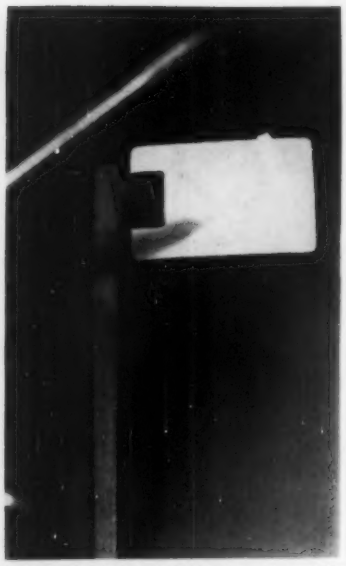
CALCULATED ALONG ELLIPSE PATH

Since the normal path of the pendulum is a long narrow ellipse, the measurements were taken on three points of this path which would most easily identify any variation. They were: the amount the entire elliptical path appeared to rotate; the conjugate, or smaller axis of the ellipse; and the lateral motion of the ellipse at the point where the pendulum reverses direction.

Measurements were taken 2½ hours before the eclipse and every 5 minutes after it began. At conclusion of the experiment, the apparent rotation of the pendulum had been slowed 2.7°. This meant that rotation of the pendulum did not proceed at the expected rate; it was 2.7° short of the expected travel arc. These deviations were only 20% as severe as the 15° deviation recorded by the scientist from France.

In explaining his experiments Dr Allias would only say that at this point in the investigation the motion "cannot be tied with any known phenomenon." To this now are added the reactions of Halls and Robinette. Still another opinion is that, if anything, the deviation is caused by structural changes in the earth itself. ■

THERMAL SHOCK of a 1250-F temperature change failed to damage Nucerite sample. Plate was heated in oven for 15 min., then cooled with icewater.



1600-F TEMPERATURE produced by oxyacetylene torch did no damage to molybdenum-base Nucerite plate during five-min. test.

Ceramic-coated Metal Resists High-temperature Corrosion

ROCHESTER—Nucerite, a construction material that resists attack by corrosive vapors at 1300 F, has been developed by Pfaudler Div of Pfaudler Permutit Inc.

The material is a ceramic bonded to a metallic base. Base metals have included stainless steel, mild steel, molybdenum, Inconel and Hastelloy. Niobium and tantalum are being tested for possible use because of their ability to maintain strength at high temperatures.

Though only in the development stage, Nucerite has undergone successfully the following tests:

Impact—A Nucerite plate (0.20-in. ceramic coating on ⅜-in. Inconel plate) was only slightly crushed at the surface by the impact of a .22 cal bullet fired from 25 ft. No metal was exposed. The bullet struck the coated side of the plate. A 1.2-lb steel ball dropped from 9 ft crushed the Nucerite outer plate slightly.

Modulus of Rupture—A rod of mild steel, with Nucerite coating, withstood a stress of 85,000 psi without failure or permanent deformation. In the test the rod was suspended across parallel knife edges and lead shot was gradually added to a plastic cylinder suspended from the rod. Bend under stress was approximately ⅛ in.

Thermal Shock—A sample with 0.020-in. ceramic coating on a ¼-in. mild steel plate was heated for 15 minutes in a furnace at 1250 F. Icewater was poured over the plate immediately after removal from the furnace. The temperature change to 32 F did no visible damage.

Abrasion—A sample was subjected to three 15-min. periods of agitation in a standard Porcelain Enamel Institute Abrasion Tester. A mixture of shot, silicon carbide and water was used. Nucerite proved to be four times more abrasive-resistant than regular lab glass. In a similar test against four porcelain-enamel samples Nucerite again showed far less wear.

Heat-transfer—The conductances of Nucerite and several other materials were compared on the basis of heat flow through ⅜-in. material. Results were: Nucerite 170, fused alumina 45, Pyrex glass 20 and porcelain 12 btu/hr/sq ft/°F.

Oxidation—Although refractory metals oxidize at high temperatures, with this ceramic coating molybdenum base metal was uneffected by an oxyacetylene flame (1600 F) for five minutes.

Company experts say Nucerite properties come from its large number of small crystals. This is the result of carefully controlled nucleation and crystallization during the heat treating after the coating has been applied to the base metal.

At present the material is undergoing a period of selected field tests, after which production is expected. ■

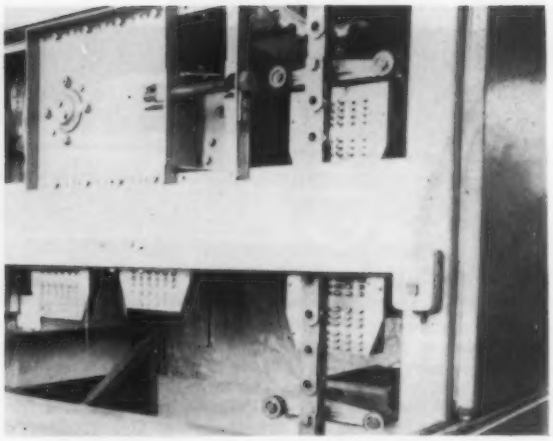
Engineers Decline Company Offer At Boeing

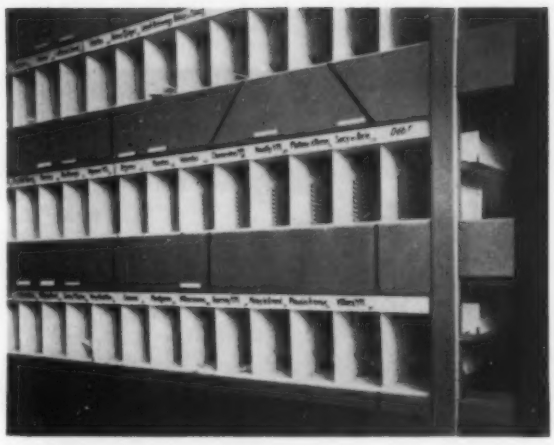
SEATTLE, WASH.—Engineers at Boeing's Wichita and Seattle plants have rejected the company's new contract offer, according to word from the Seattle Professional Engineering Employees Association. The vote reportedly was 87% against. The union objected on three counts:

The company, it says, has dropped a 14-yr provision, that assures engineers two weeks' notice before layoff.

The company proposes to remove restrictions governing which engineers should be dropped when a layoff is necessary. Heretofore, the union contract has stated that the more-able engineers be transferred to other company projects and the least able, dropped. Without this restriction, the union contends, the company is free to drop employes on a project basis rather than a merit basis.

Finally, the company offered a 3% general increase this year. Usually, the general increase is comparable to that offered new graduates. This year's grads at Boeing are getting 4.5% more than last year's. ■





ELECTROMECHANICAL DISTRIBUTOR in Paris Post Office has six operator stations. As each letter passes by the window (photo above) of this station, operator taps out a 2-letter code combination on keyboard. Heart of machine is the chain conveyor (upper right) which moves 6-compartment carriers through four levels of the machine at rate of 78 fpm. Back side of machine (lower right) shows three levels of bins into which letters fall after encoding.

French Electromechanical Sorter Handles 20,000 Letters per Hour

PARIS—An electromechanical mail sorter which processes 20,000 letters per hour for 300 different destinations has brought the French Post Office Dept a step closer to automatic mail handling. Manned by six operators, the 65-ft-long machine is the first unit to go into service in a suburban Paris mail depot where, during the next few months, more of the mail devices will be installed.

Heart of the machine is a chain conveyor fitted with 6-compartment carriers that pass through four levels of the machine at a rate of 78 fpm. As a carrier passes along the lowest level, each of its compartments gets a letter and a mechanical code from one of the six operator's stations. Then, as the carrier continues on past 300 bins arranged on three levels, each compartment dumps its letter at the bin whose code corresponds to the compartment's.

A combination of "in" or "out" positions for 10 lugs establishes the particular code given to each compartment. Lug settings are made by solenoid-operated plungers controlled by signals from operator's console.

The operator reads the address on the letter and taps out a 2-letter code on his keyboard. The machine electronically transcodes the 2-letter code into the "in-out" signals for the lug-setting plungers.

At each of the 300 receiving bins, the compartment codes are read by a grooved drum. When the compartment code matches the bin code, all the lugs are depressed and a shutter at the bottom of the compartment opens to drop the letter into the bin.

To achieve high sorting speed, and to provide a flexible coupling between the carriers (these pass through the machine at constant speed) and the operator's output of 2-letter codes, the code-setting equipment at each station has four sets of lug-setting plungers. The 2-letter codes are stored temporarily in a 4-stage electronic memory.

When the code for a letter is tapped out on the keyboard, it enters the memory and the letter drops into the main chain conveyor. The letter and its code remain synchronized as the code passes through the memory, stage by stage, after which the letter heads for the chain conveyor. In this way the set of plungers, which code the compartment into which the letter drops, set up the proper "in-out" lug positions for destination.—**Art Erikson, McGraw-Hill World News**

Parade of '61 Models Begins

Among changes in 1961 Buicks are a 75-lb lighter frame, achieved through elimination of side rails; starter control at the ignition switch; and abandonment of torque-tube drive in favor of Hotchkiss. The latter necessitates control links to torque in the rear. The new Buicks have only 4 grease fittings—all other suspension and steering linkages are lubricated for life. Two premium-gas, V-8, cast iron engines are available. One produces 250 hp at 4400 rpm; the other, 325 hp. Styling note: Though a GM wag noted, in the fall of 1958, that portholes can't help a sinking ship, hence their abandonment in 1959, the "portholes" reappeared this year and will stay at least through 1961.

Faithful to its policy that styling will not be changed for its own sake, Studebaker will show a 1961 Lark that is outwardly distinguished from last year's models only by dual headlights and some softening of the former boxy body lines. Under the hood the 1961s have a new engine, the Skybolt Six, designed around capabilities of the Packard V-8 transfer line. The engine has overhead valves, 8:1 compression ratio, and produces 112 hp at 4500 rpm—11 more than Ford's Falcon with the same 170 cu in. Other new features are timing gears, rather than a chain, and long ramp and low acceleration cam.

Ford's Comet, a lanky brother of the Falcon, will be little changed in 1961. Its unitized body, structurally and dimensionally identical to the Falcon, is mounted on a 114-in. wheelbase. Front coil springs are mounted with a rubber-cushioned strut between lower arm and front structural member to permit wheels to roll back, up and over bumps. Similar action is achieved at leaf-spring-mounted rear wheels by a 2-in. rubber front-eye bushing. An optional 170-cu in., 6-cyl ohv engine is rated 20% better acceleration than the standard 144.3-cu in. engines.

AMA Survey Again Finds R & D Climb

NEW YORK—Some 400 corporations, representative of US industry, will average 10.7% more for development of new products and processes in 1960 compared with 1959. This is the word from the American Management Association on basis of a midyear survey.

Of the 402 corporations from 26 industries surveyed, the AMA found that 66% will increase budgets, 7% will decrease budgets and 27% will leave them unchanged. Especially large increases were reported by electronics, 16.8%; miscellaneous machinery and parts, 22%; stone, clay and glass, 19.2%; plastics and molded products, 14.6%; and instruments and control equipment, 14%.

The 400 companies spent an average of 3.7% of 1959 sales for product development that year, the survey showed. The leading industry was electronics with 7.7%, followed by instruments and control equipment, 6.1%.

Discussing the survey, Dr Philip Marvin, manager of AMA's research and development division, says growth companies today are trying to get more for their product-development dollar rather than spending more dollars for product development.

"Most companies don't know the actual costs of developing their new products," Dr Marvin says, even though this cost "is a basic factor in making the most important decisions about the future." ■

Vacuum Effect on Alloys

WASHINGTON—Notch sensitivity of Inconel X, Udimet 500, and other high alloys, may be adversely affected by operation in vacuum at high temperatures, says Naval Research Lab. Stress-rupture tests of notched and unnotched samples at 1500 F show the materials have a slightly longer rupture life in vacuum than in air when heat-treated to a high-strength level. But, at lower strength levels, the reverse is true; notch sensitivity increases when parts are operated under vacuum conditions. Furthermore, the creep-rupture life in air of Inconel X in the low-strength condition actually seemed to be increased by the presence of a notch. Tests are now underway to determine causes and effects. ■

Engineer "Dignity" Held Cause of Production Woes

MILWAUKEE—The deterioration of good relations between Engineering and Manufacturing is directly related to the disappearance of complete mechanical draftsmen, in the belief of A. G. Hall, works manager for Nordberg Manufacturing Co. He spoke during a special panel at the recent Production Forum of the Society of Automotive Engineers (SAE) here.

Hall and fellow members of the panel agree that old-time draftsmen knew materials, processes, machine capabilities—and this led to a near-perfect understanding between engineering and production. Today, the panel said, the college-trained engineer believes such work beneath his dignity; his lack of actual shop and foundry experience forces Production to attempt operations beyond the capabilities of shop machines. This, in turn, pushes scrap rates to new highs, further straining the relations between Engineering and Manufacturing.

PANEL SIFTS SOLUTION

Can apprenticeships in drafting help? Part of the problem was said to be the promise made by recruiters that design and management positions are available to college graduates, and that mechanical drafting is not required. A speaker from the audience suggested that college students do specialized drafting work for a company while still on the campus. This would require that professors "sell" the student on mechanical drafting—in many schools this isn't done.

Labor also road-blocks the proper training of engineers in shop procedures and practices, said conference chairman R. A. Hedden, works manager for Allis-Chalmers Manufacturing Co. Freedom of engineering training in the shop is restricted by many union contracts and the engineer-in-training is relegated to an observer's role. Some companies are writing into contracts the right to train engineers in the shop and foundry.

S. D. Mills, manager of industrial engineering, A O Smith Corp, said his company took outstanding highschool graduates and trained them as draftsmen. Trainees spend 20 hours in class and 20 more on the board each week. After class training, they spend 20 hours a week in the shop and foundry.

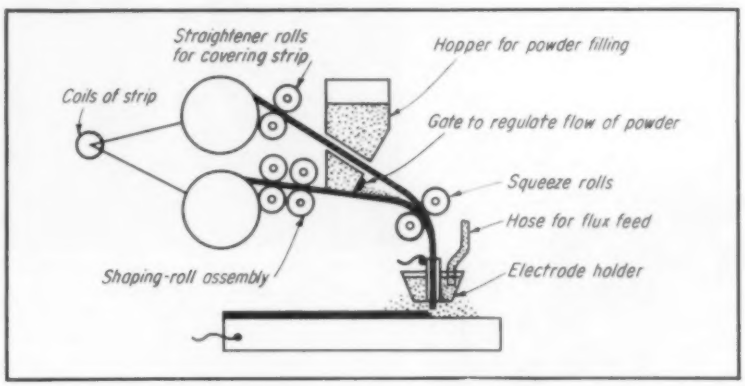
Many in the audience felt the problem to be an economic one. Higher pay would break down many of the college-trained engineer's prejudices against mechanical drafting and would produce better all-around engineers. Old-timers, it was pointed out, learned their trade by trial and error, and lacked either the ability or desire to go further in the company. Consensus was that a good college-trained engineer, with intimate shop and foundry experience learned while working on the boards, can do much to improve over-all relations between engineering and manufacturing. ■

Sperry Engineers Vote to Decertify Union

GREAT NECK, NY—In a decertification election at Sperry Gyroscope on Sep 8, the company's engineers voted to do away with their bargaining agent, the Engineers Association, a unit of the International Union of Electrical, Radio and Machine Workers (IUE-AFL-CIO). The ballots, according to NLRB tally, showed 1509 for the union, 1724 against. More than 90% of those eligible voted.

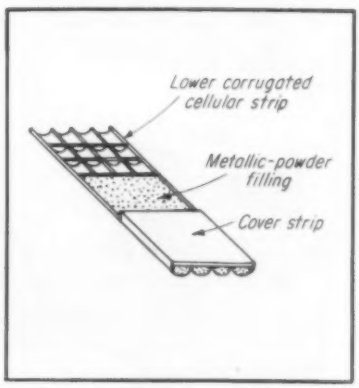
The 14-year-old Engineers Association had voted last May to affiliate with the IUE and became Local 445 of that national labor organization (*PE*—Aug 29, *p* 15). This led to a petition for an NLRB decertification election. It was signed by 1100 Sperry engineers, draftsmen and technicians who opposed the affiliation.

In its election campaign, the Decertification Committee argued that increased power, which the Sperry union would gain by affiliation with IUE, would lead it to seek a union shop contract. ■



Welding Tape Allows Varying the Constituents

Welding tapes are being used in Russia in place of rigid welding rods for welding and hard-facing applications. The powder-filled tape sandwich (illustration at left shows its three elements) can weld or metallize with either automatic or semiautomatic equipment. Tape is continuously manufactured during welding by equipment mounted directly on the welding machine (right). Filling constituents can be varied at will to meet requirement, and tape can also be cut to convenient lengths for manual metallizing. For welding, a modified automatic welding unit using 1250 and 1350 amps at 35 to 40 volts can work off ac or dc. Maximum speed of deposition obtained has been 72 ft/hr.



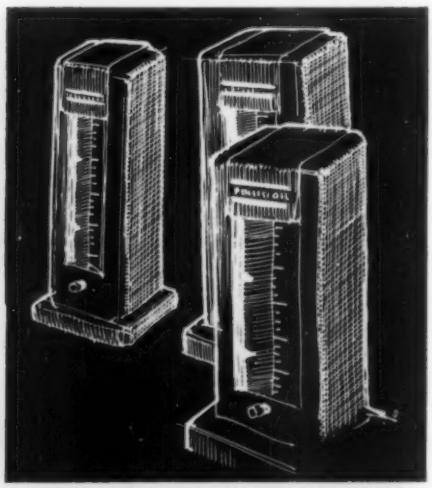
On a semiautomatic machine, used for hard-facing, the electrode is arranged horizontally between two flux layers. This equipment uses single-phase ac or dc at 400 to 500 amps. Speed of deposition varies between 23 and 30 ft/hr.

RICHARD S. LATHAM,
Partner, Latham-Tyler-Jensen, Chicago
President, American Society of Industrial Designers

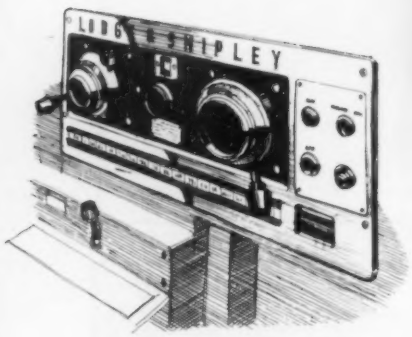
TRENDS IN APPEARANCE DESIGN

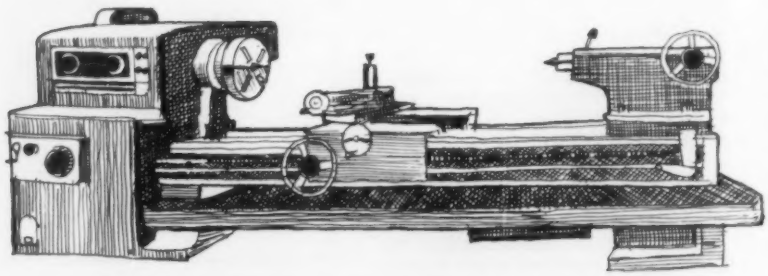
PRODUCT PLANNING IS A RARITY

The editors of PRODUCT ENGINEERING asked Richard Latham to make a personal tour of the Machine Tool Exposition in Chicago and thereafter to present a no-holds-barred opinion of what he saw. Here it is, with his on-the-scene sketches.



Instruments and tools produced by Sheffield Corp have a family resemblance excellent for corporate identification. It is undesigned but neat. The over-all silhouette is recognizable and good, with continuity of form, and the signature is uniform in treatment. Here's a fine example of the first step in good industrial design—to achieve a recallable functional shape.





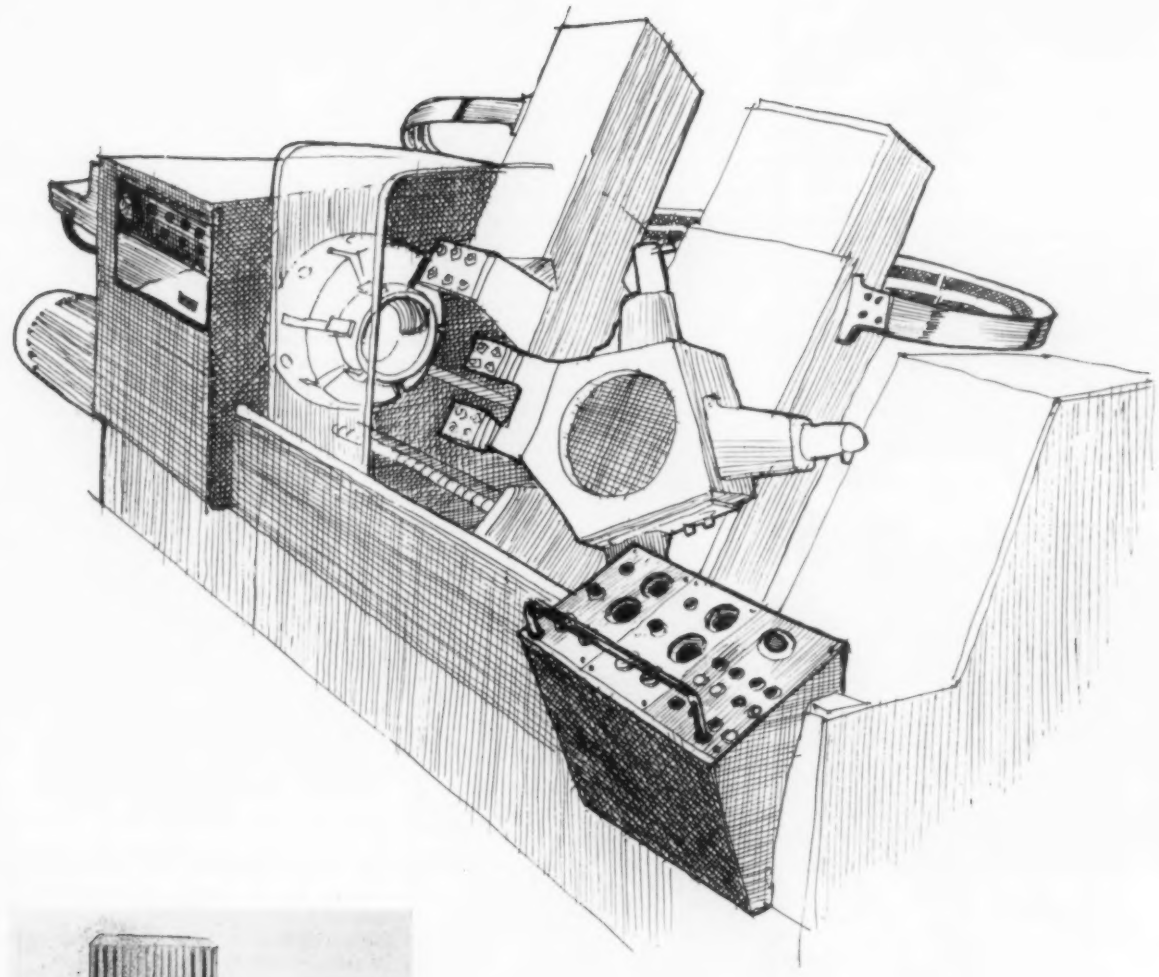
In the Lodge & Shipley lathe, the designer worked with forms while the engineer worked with functions. The result is dignity and logical shapes, not over-detailed, and sound over-all treatment. Control positioning and development are good, not a heterogeneous collection of hard-to-read elements massed for effect, but an organized grouping. Here is the second step—to fit form to function, not to add it as an afterthought.

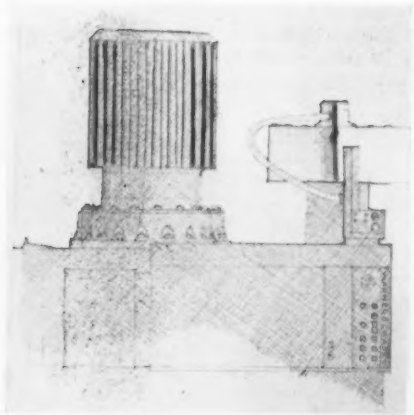
■ To an industrial designer who once operated machine tools, the Machine Tool Exposition in Chicago earlier this month presented a fascinating, but at the same time discouraging, picture. Overlooking the regulations, which permitted no display lighting or use of color other than a standard gray, exhibits were in general the essence of solidity and stolidity. With few exceptions, there seemed little, if any, effort to organize the elements of a machine for good over-all design or for operator comfort or convenience. Conspicuous were attempts to "pretty up" or apply the "cosmetic" approach rather than achieve sound, integrated design. Many machines looked almost like their counterparts of 20 years ago—the same projections, excrescences, lack of organization.

Basically, a machine tool is a heavy mechanism of steel, either cast or fabricated, which should convey an impression of strength, rigidity, dependability and accuracy. But many of the models shown have been superficially "face-lifted"; the effect nullifies the desired impression, just as surely as over-dress or over-makeup on a woman scarcely conveys an idea of gentility. Nonfunctional lines or shapes have been created that suggest a space vehicle or an automobile-styling rather than design. In other cases, a corporate identification symbol or monogram, modern and basically pleasing in design, has been plastered on traditional shapes, creating somewhat the effect of a

continued, p 22

IN MACHINE TOOLS



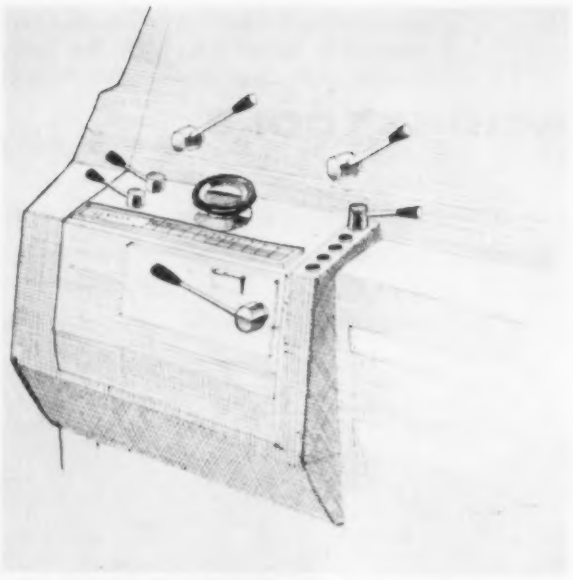


A fresh approach to an old problem shows in this Warner & Swasey Servo-feed turret lathe—a logical, well-thought-out treatment that "looks right." The movable control console in foreground above is a sensible out-growth of the old turret-lathe skirt. The stainless strip in graceful-shape covering and supporting the control cables is excellent, as is the canti-levering of the drive motor (detail). All combine to produce a cohesive whole—a unified machine—and a first-class example of what can be done when engineer and designer understand each other on a long-term basis. This is no one-of-a-kind or short-term consultant production, but thorough product planning and design to produce a machine that uses tradition but doesn't ape it, that weds numerical control to the machine tool instead of pasting it on.

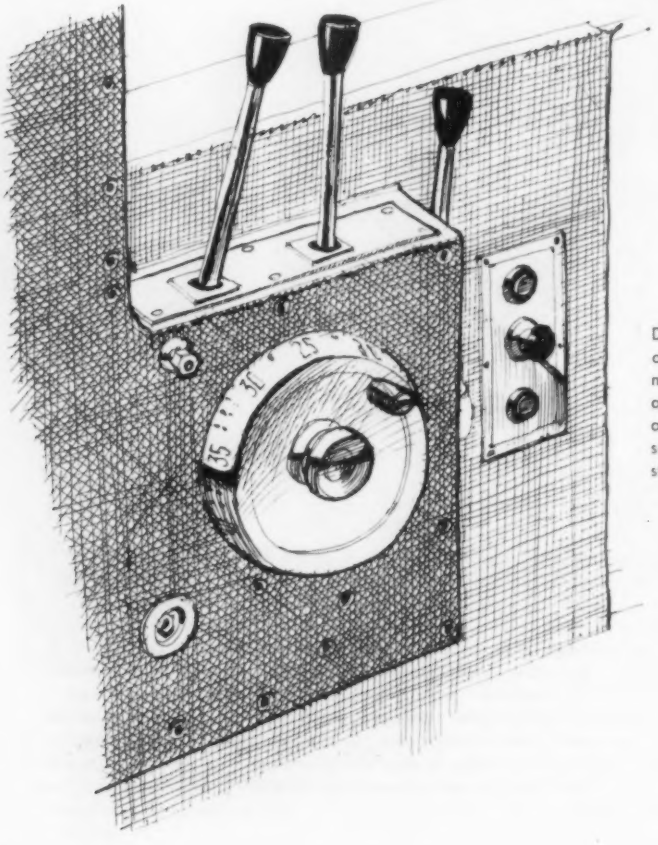
beauty spot on a charwoman. Or handwheels and handles have been prettied up with color that has no significance.

Here, as in many other fields, the need for product planning is evident and urgent. Companies cannot continue to "sit tight" on past and present product acceptance, because competition—both domestic and foreign—is increasing. Ideas are going begging within companies; the occasional flashes of well-integrated design in products of companies without a formal design program prove that. The typical organization must be reoriented to accept rather than kill these ideas, to suit tomorrow's product to tomorrow's market. True innovation is sadly lacking in most machine tools, probably—as is most other instances—because the producing company is organized to squelch it.

There are exceptions, of course, and some of these we propose to show, to illustrate what has been done in basic improvement of appearance design. ■



Control grouping and organization are outstanding in the Sidney lathe, which also has a massive and reliable over-all appearance. The controls suggest ease of grasping and functioning, yet are neither obtrusive nor garish.



Designer's understanding the operation of the machine is obvious in this control area for the Cincinnati Hypowermatic miler. The three control handles and dial are interrelated and set with relation to hand and eye for maximum readability and ease of control. Here is the third principle of successful industrial design—to have the designer understand, and be involved with, the use function.

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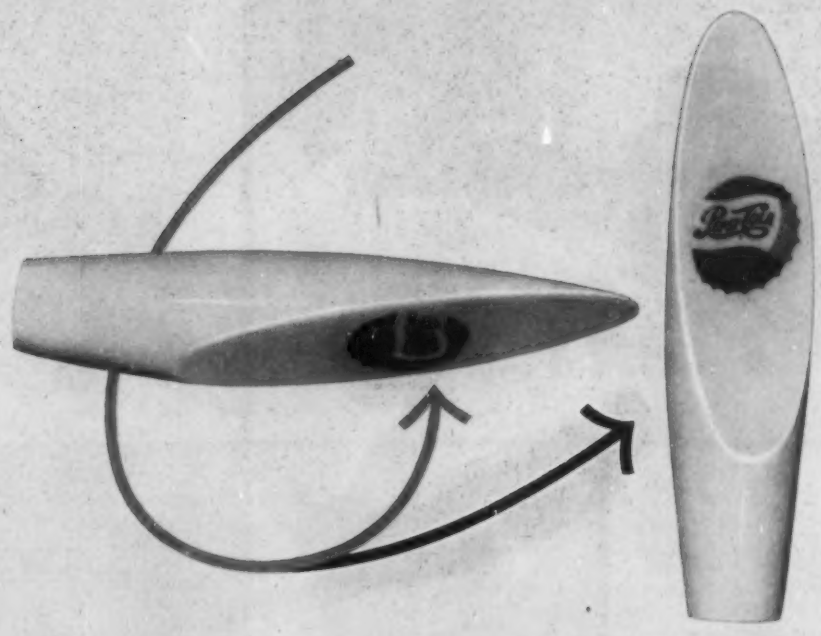

Another way to make folks say, "Make mine a Pepsi"

Photographs can't do justice to the beauty, utility and durability of this Pepsi-Cola dispenser handle. Molded of gleaming white melamine with the famous red, white and blue Pepsi bottle cap in permanent molded-in color, it provides that all-important instant identification to the thirsty millions who prefer this popular beverage. Handsome, yes, plus all the strength and rigidity needed to meet the rigorous demands of fountain service.

The Pepsi handle is not an ordinary molding job. In fact, it involves some rather unusual techniques which come only with years of experience. And that is, of course, a mighty good reason to specify CMPC on your next job.

This is another CMPC "White Gloves" molding. For maximum protection against material contamination, this product was molded under highly controlled production conditions involving special dust control measures and a protective materials handling system. This is another example of CMPC's specialized techniques and facilities for producing the best in molded plastics.

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Where can you profit from the satin touch of today's brushed Nickel-Chrome Plating? Consider its practical advantages—and its fresh, fashionable sales appeal—for refrigerator doors, ovens and ranges, air conditioner grilles. For virtually *any* major appliance or decorative component.

For useful information on decorative plating, write for our new booklet, "*The Contribution of Nickel and of Chromium to the Durability of Decorative Plating.*" It's yours for the asking.

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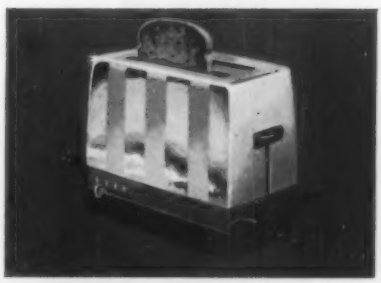

New idea! Exciting two-tone finishes are easily produced by selective buffing. Bright-and-brushed finishes offer many new design possibilities.

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Nickel makes plating perform better longer

Coro-Gard® 1706 withstands

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METAL coated with Coro-Gard 1706, right side, shows no effect from salt spray attack. Corroded left side is untreated.

2000-hour corrosion attack

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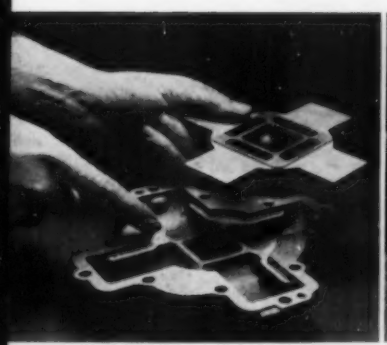
Specify CORO-GARD 1706 Coating for steel, aluminum, wood, concrete, cloth, even some plastics—wherever corrosion or abrasion must be fought. It provides maximum protection at low cost, brushes on as easily as paint. Self-priming, it goes on vertical surfaces with minimum sagging, provides unusually high coverage for economical use.

This neoprene rubber based coating air-cures to a tough, rubbery, protective film with exceptional resistance to corrosive fluids and fumes, water and abrasion. It successfully resisted a 2000-hour salt spray attack, a 20-week submersion in 20% solution of hydrochloric acid, and a six-month weather exposure in Miami, Florida. After all this, CORO-GARD 1706 Coating still maintained its exceptional adhesion and flexibility, its corrosion and abrasion resistance.

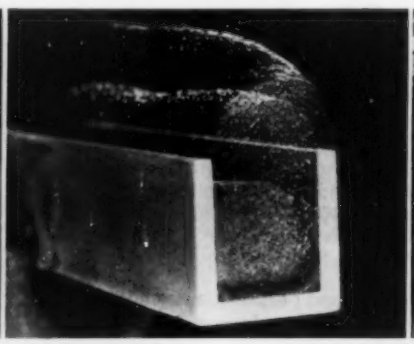
See how CORO-GARD 1706 Coating can help you. For complete information, write today on your company letterhead, specifying area of interest, to: AC&S Division, 3M, Dept. SBS-90, St. Paul 6, Minn.

"CORO-GARD" is a Reg. T.M. of 3M Co.

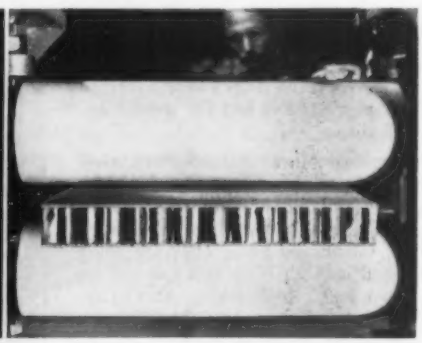
News about other 3M products



SIMPLIFIED PRODUCTION. 3M Adhesive EC-1386 bonds sections of hollow castings. This simplified method of producing complex castings eliminates high rejection rate of sand molding, costly machining, equipment required for mechanical fastening. The adhesive bond fills voids, cures quickly, can be machined for final touch-up.



SURE WAY TO SEAL. 3M Heat Expandable Sealers expand up to 125% under the normal heat of a paint-baking cycle, cure to a tough, flexible mass that keeps out dirt, water and weather, completely seal even the most irregular gap or seam. The unexpanded solid is also efficient as a gasket replacement sealer, flange sealer, and for other sealing jobs.



COLD SANDWICH BONDING. 3M Adhesive EC-1357 makes it possible to bond sandwich panels with a nip roller or cold press. You need no clamps or heated presses to complete tough core-to-skin bonds that resist moisture and high and low temperatures. This one adhesive bonds a variety of materials quickly, economically. Because of its dark color, it absorbs infrared heat quickly, dries fast.

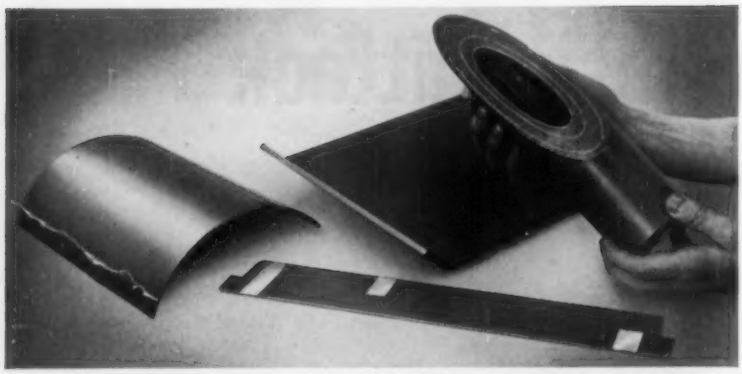
ADHESIVES, COATINGS AND SEALERS DIVISION

MINNESOTA MINING AND MANUFACTURING COMPANY

...WHERE RESEARCH IS THE KEY TO TOMORROW

3M COMPANY

Important facts to know about laminated plastics



A few Taylor composite laminates (left to right): copper-clad section; sandwiched copper component; Taylorite vulcanized fibre-clad part; laminated tube, copper inserts.

Composite Laminates Open Up New Design Opportunities

While the great variety of commercially available laminated plastics satisfy most electrical and mechanical requirements, there are applications that can benefit from the combination of properties provided by composite laminates. Recent advances in bonding techniques have made it possible to bond virtually any compatible material with a laminate. These can be supplied as clad or as sandwiched materials. And they can be molded into many shapes to fit design requirements. Taylor is presently supplying to order the following composite laminates:

- **Copper and laminated plastics.** Clad for printed circuits and formed shapes. Sandwiched for special applications.
- **Taylorite® vulcanized fibre-clad laminates.** These combine the high strength of laminated plastics with the superior hot-arc-resistance of vulcanized fibre. They are being used in both high and low-voltage switchgear applications. Also in applications where the high impact strength of vulcanized fibre may be advantageous.
- **Rubber-clad laminates.** Almost any type of natural or synthetic rubber may be used as the cladding material. These laminates are widely used for condenser tops in wet condensers to protect the laminate against highly alkaline electrolytes. They also have application in any part where sealing or chemical resistance is needed.
- **Asbestos-clad laminates.** For applications where high heat- and arc-resistance are required.
- **Laminate-clad lead.** Lead sheets sandwiched between Grade XX paper-base laminates have been used for X-ray shields. The laminate provides strength and contributes to the high shielding properties of the lead.
- **Aluminum-clad laminates.** These have been used extensively for engraving stock. They also offer possibilities as printed-circuit material and as plate holders for X-ray machines.
- **Beryllium copper-clad laminates.** Beryllium copper is nonmagnetic and a good conductor—properties that give these laminates possibilities in many applications.
- **Stainless steel-clad laminates.** Applications where nonmagnetic properties are required. Also in certain corrosive environments where the resistance of stainless steel to attack is an asset.
- **Magnesium-clad laminates.** These laminates have been produced in 108-in.-long sheets for use as screens for X-ray operators. Weight was a factor.

Our design and production engineers are constantly developing new materials, new applications, and new procedures for fabricating laminated plastics. Our experience is yours for the asking. And if you have a problem requiring assistance or more information on composite laminates, write us. Also ask for your copy of Taylor's new guide to simplified selection of laminated plastics. Taylor Fibre Co., Norristown 39, Pa.

Taylor

LAMINATED PLASTICS ■ VULCANIZED FIBRE

READER TO EDITOR

Problems of an Inventor

To the Editor:

Brother, I've got Mark Twain beat a mile. I've discovered that everyone talks about their documentation problem but no one does anything about it. In attempting to crack the so-called documentation field, I have developed six patentable devices since April of this year. Now, these six devices are good, and a wide assortment of people in the field have concurred—therefore you'd expect me to be sitting on my yacht with a Wahine on one side and a cold rum collins on the other—and cuts on my fingers from the string used to bale up the money. The true facts may turn your stomach.

Knowing that "Dr - - - -" of a large Eastern company had one heluva time trying to get established (nearly six years)—I wrote him a sl.ort, legal, concise report stating that I had a device right up his company's alley with substantial market. About seven weeks later I heard from their 5th-string patent attorney and was given the usual "waiver" which I had expected. However, this 4-page document was a little different. After wading through all the gobbledegook, it stated, in effect, "while we are willing to discuss your device or idea with you, we want you to know that we rarely ever take a product in from the outside." Cute?

Another company called me in on an internal problem for which I indicated the answer and costs. In passing, I indicated that I had several data-processing devices—and were they interested? "By all means—we have tried to encourage fellows like you." Accordingly, the waiver was whipped out, signed, and about 6 weeks later the patent attorney's clerk explained to me that I must submit a complete set of blueprints, instructions, justification, marketing data, and other material. They didn't want to waste the time to come and see my working model until they had studied my data to see if they wanted to come and see my model. I live 10 minutes from their plant.

The point is that despite the fact that individuals still account for some (perhaps most) of the significant inventions, the team-research idea still seems to hold favor—and anyone who walks in off the street is probably a crackpot. Having been in the position of having to screen ideas from the outside, I'm aware of how difficult it is to separate the inventor's enthusiasm from the facts—but I've done it.

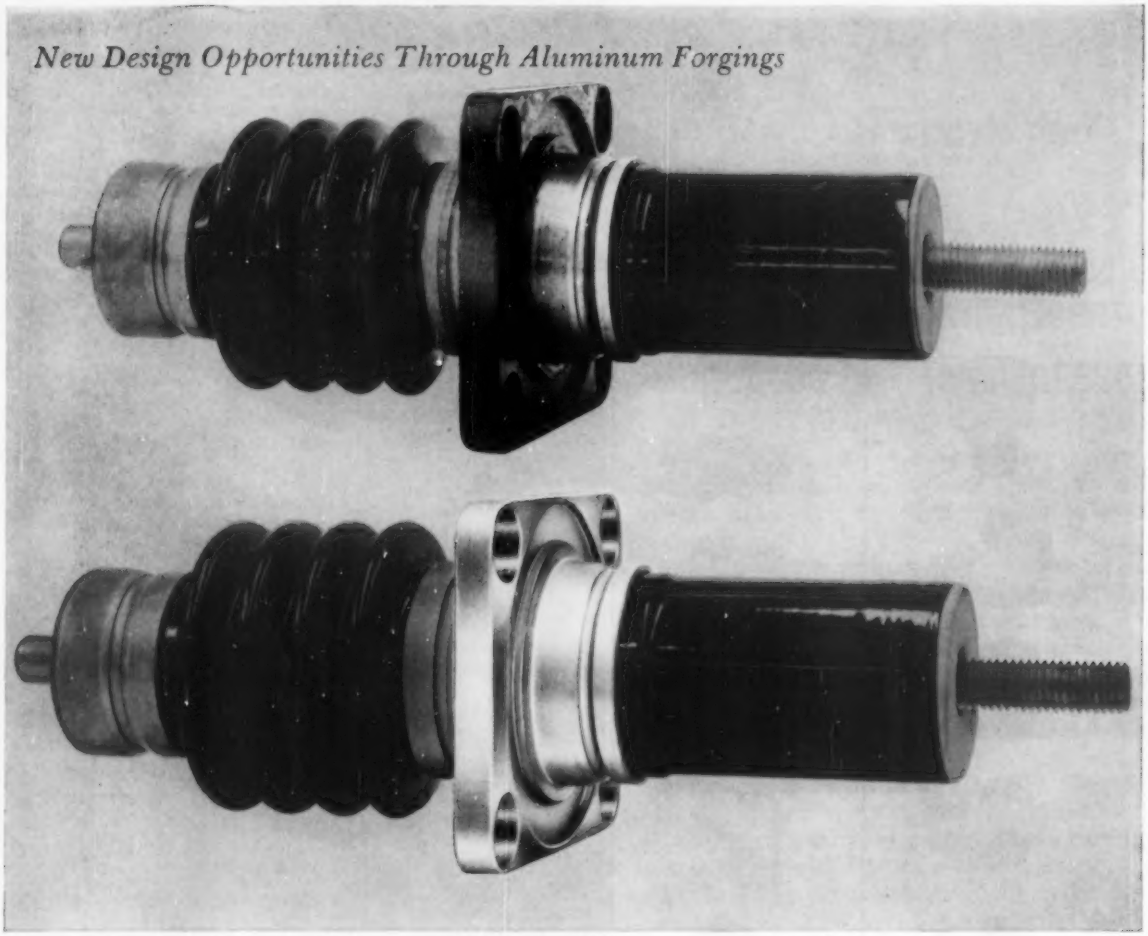
From my experiences in the past few months I have learned a few things which can be summed up as follows:

1. Companies and government establishments say that they treasure and desire good ideas, machines, and devices—but they don't.

2. Compaines that advertise "Do you have a Product Idea?" (like your July 11th issue—p.118) in magazines, and daily newspapers are looking for a fast buck or something, and in fact rarely, if ever, even bother to reply to a well-thought-out

continued on page 30

New Design Opportunities Through Aluminum Forgings



which bushing has 5 new advantages?

The one below—because its flange is a strong, light Kaiser Aluminum forging!

The bushing at the top, used previously on large transformers by Westinghouse Electric Corporation, includes a two-piece steel and copper flange assembly with a brazed joint. The bushing below features the forged aluminum flange that replaced it. Here's why:

1. **Increased Reliability.** With no brazed joint, the possibility of leakage at this point was eliminated, and costly testing of the flange is no longer required.

2. **Simple One-Piece Design.** By designing the bushing flange as one piece instead of two, important cost advantages were realized over the steel and copper assembly.

3. **Added Strength.** The forged aluminum bushing flange is stronger. During the forging process, grain flow lines of the metal concentrate at points of greatest stress to produce a part of maximum strength and toughness.

4. **Light Weight.** The aluminum bushing flange weighs only one-third as much as the steel and copper bushing. Westinghouse saves money on shipping costs.

5. **Corrosion Resistant.** The aluminum bushing flange can't rust, resists corrosion. Costly painting is eliminated.

Find out now how aluminum forgings can best serve your design requirements. We'll be glad to assist you—just mail the coupon!

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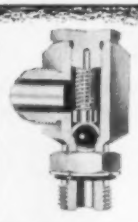
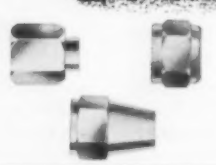


TUBE NUTS



Andy Anchor says:

For complete specifications on these precision-made, space saving, trouble saving, hydraulic fittings, write today for Anchor's New Catalog No. 206

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Branch Plants: Dallas, Texas, Plymouth, Mich.

idea. These people don't seem to realize that products can be invented to match their requirements if the inventor knows the type of thing they have in mind, something about their engineering, production, and marketing capabilities.

3. Most of the people in corporate or government design, research, and development can only say no—and never yes. Unfortunately the only guy who can say yes is too busy or not well-informed enough to even discuss the matter. Of course, the no people don't like to take a chance, so they'll always be inclined to be conservative.

4. Corporations and government facilities are notably slow in replying to any form of correspondence which smells of being a good idea or something new. (Even the National Inventor's Council is guilty.) And when the reply does come, it only seems to place more obstacles in your path by requesting outlandish amounts of data. All this, when a working model would knock their eye out in two minutes. —HENRY STAATS
Deerfield, Ill

COMING EVENTS

SEPTEMBER

26-28 . . . . Standard Engineers Society, Annual Meeting, Hilton Hotel, Pittsburgh

26-29 . . . . American Welding Society, National Fall Meeting, Hotel Penn-Sheraton, Pittsburgh

27-30 . . . . American Rocket Society, Space Power Systems Conf, Miramar Hotel, Santa Monica, Calif.

OCTOBER

5 . . . . Society of Plastics Engineers, Regional Technical Conf, Plastics vs Corrosion, Mark Hopkins Hotel, San Francisco

9-11 . . . . American Society of Mechanical Engineers, Rubber and Plastics Conf, Hotel Lawrence, Erie, Penna.

10-14 . . . . Society of Automotive Engineers, National Aeronautic Meeting, Ambassador Hotel, Los Angeles

10-15 . . . . Institute of Radio Engineers jointly with ASQC, Reliability training Conf, Texoma Lodge, Kingston, Okla.

13-14 . . . . Institute of Radio Engineers, Symposium on Engineering Writing and Speech, Bismark Hotel, Chicago

16-21 . . . . Society of Motion Picture and Television Engineers, International Congress on High-speed Photography, Sheraton-Park Hotel, Washington.

17-19 . . . . American Society of Lubrication Engineers jointly with ASME, 7th Annual Lubrication Conf, Statler-Hilton Hotel, Boston.

17-21 . . . . American Society for Metals, National Metal Exposition & Congress, Trade & Convention Center, Philadelphia

BEST BUY FOR CHEAP AIR

UP TO 5hp... NEW WORTHINGTON MONOBLOC X COMPRESSOR

Based on purchase price, on extremely long compressor life . . . and on safety, too . . . your best buy for a 1½- to 5-h.p. air supply is the new Worthington MONOBLOC X-Compressor.

First, the MONOBLOC saves you $30 or more for parts and labor because it comes completely wired. There's no starting switch to buy and install and wire in.

It's more economical, too, because all your money goes to buying a quality motor, compressor, controls and tank. You don't waste it on unnecessary belts, belt-guard, sheaves, long base and on the labor required for assembling them.

Is floor space important to you? The MONOBLOC vertical tanks save over 60% of space required by old-style horizontal units. A 10" radius circle for the 60-gal. tank; a 12" radius circle for the 80-gal. tank.

The MONOBLOC costs less to run. All power goes to the compressor—no power loss in belt friction. (No belt guards or belt replacements.)

Of course, you want long compressor life. The MONOBLOC is built with the new Worthington X-Compressor design that virtually eliminates harmful vibration. The wide-stance X-shape design reduces vibration to the point where a coin can be balanced on the unit during starting, running and stopping.

A silicon-treated filter element removes over 99% of the dirt from incoming air—the most dangerous source of compressor wear. Tapered roller bearings cut friction. The large lubricating oil sump permits better cooling, less danger from low oil supply. These and other design features assure extremely long compressor life.

We and our distributors are ready and happy to show you why there's no better way of buying cheap air today. Call the Worthington Distributor listed in your Yellow Pages. Worthington Corporation, Section 34-7, Holyoke, Massachusetts.

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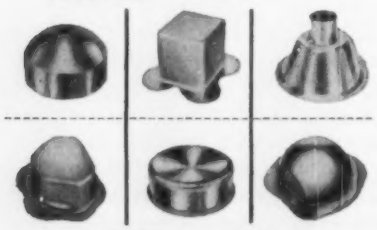

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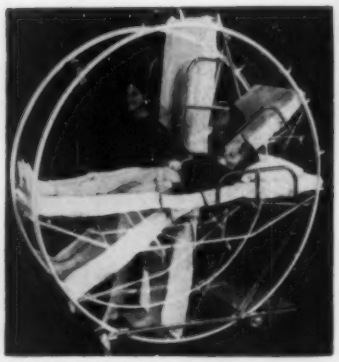
FOR YOUR INFORMATION (personal)

Ferris wheel for the feverish



Ever struggle with a hospital bed (or a hospitalized patient), trying to find the right angle for care and comfort? Struggle no more. Orthopedic Frame Co has designed this electrically operated unit that lets the patient select his own level. It's powered by a ¼-hp motor, using a 30:1 worm gear reduction, and it even has an electrically operated sling attachment for transferring the patient from bed to bath or wheelchair. Price: $695 (in quantity). Ryerson steel supplied the metal—and the photograph.

The big rock-candy cleaner

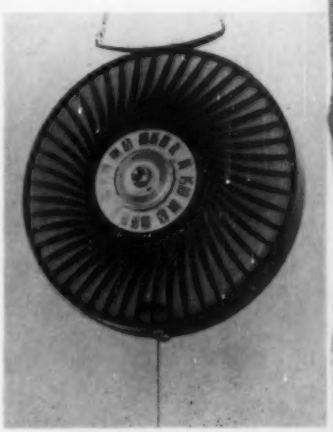
Got a pipeline problem? Chew on it. That's what one Texas Co engineer did—and he came up with an idea that was novel, patentable, and apparently effective.

The problem: removal of sludge deposits from oil lines in hydraulic pumping systems. Obvious way is to force some insoluble object through the pipe. But this, as engineer J. G. Glenney points out, may damage the engine, or plug the tubing permanently if there is a restricted section. The answer, then, must lie in use of a soluble object. What to use? Napthalene, a petroleum product, is readily available in the form of our familiar moth balls. Good idea. But it doesn't work. They dissolve too fast, or become coated and don't dissolve at all.

The final answer? To quote the patent ". . . a soluble plug having a hardness value of about 2.5 on the Mohs scale, lying between that of gypsum and calcite . . . said body comprising a substantially round, hard ball molded from a glossy sugar solution." In short, a "jawbreaker" or "sour ball." And, notes the inventor proudly, "not only is the solubility of 'jaw breakers' in oil almost exactly that required to give the best results . . . but the cost per unit plug is less than one cent as compared with an average price of 15¢ for a less satisfactory prior-art plug."

Music for squares?

They're going in circles again—Japanese designers, that is. Following up on the global clothes washer (*PE*—Aug 15, p 32) we now have word of a circular radio. This one, from Toshiba, looks a lot like a kitchen clock; and, like a clock, is designed to hang on the wall. It's transistorized, of course, has two speakers, is about 12 in. dia, 4 in. thick, weighs 5½ lb. Toshiba says it can be operated through "any hi-fi or stereo amplifier plug-in, or even with an earphone." It's powered by 4 standard batteries, with a "guaranteed" running time of 300 hr. It's now going on the Japanese market, priced at about $36 (US equivalent). —ARG



Unmasked...

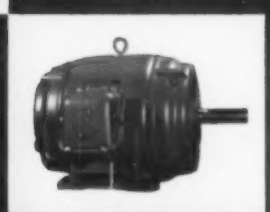
the true story of motor insulation

The selection of insulation materials—and the methods of their application—are basic factors in the performance of every electric motor. Yet their true significance has escaped many motor buyers . . . hidden by a mask of tricky trade names and claims for "cure all" insulations that simply do not exist.

To help any motor buyer become a wiser buyer, Fairbanks-Morse has prepared these two new brochures. They separate the facts from the fiction about insulation systems. They are based upon the authority of long years of proved practices. Yours for the asking . . . write: Electrical Division, Fairbanks, Morse & Co., Freeport, Illinois.

"PROCESS AND MATERIALS"

"SELECTION AND APPLICATION"



FAIRBANKS MORSE ELECTRIC MOTORS
FROM ½ TO 10,000 HP.

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ELECTRICAL DIVISION

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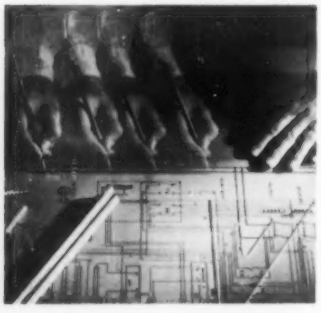

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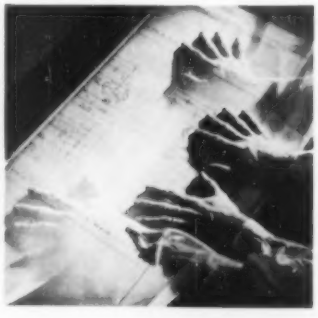

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PRODUCT ENGINEERING HORIZONS

SEPTEMBER 26, 1960

RIGHT QUESTION?

Late in World War II, a number of visitors came to me with peculiar questions like, "How can I drill small deep holes in stainless less than hole diameter apart?" Or, "How can I gage a periphery with respect to a bore 6 in. away?"

These questions immediately give rise to answering ones like: "What kind of stainless?" "What's the hole diameter and depth?" "What's the shape of the piece?" In these cases, all that information was top secret; these were parts for the first atom bomb, or for the plant at Oak Ridge, which officially didn't exist.

There was a reason for vagueness in these cases; military secrecy was involved. But in some of them, neither the contractor nor I could make an intelligent suggestion because neither of us knew the real purpose or real need. Somebody somewhere was making arbitrary decisions about what we two Americans could be told–and it was affecting the quality of the job. Surely security need not be so secure that the job must suffer.

I quote this example because it is extreme. It dealt with the atom bomb in wartime. I have known of hundreds of others in which the self-imposed or company-imposed "security" was a joke, and the job suffered just as surely.

Every supplier suffers from this continually. As one mill-supply salesman told me: "Shop men ask me for certain drills, but what they're really buying–or needing–is a certain number of holes of a certain quality in a certain time. Maybe I could advise a better drill, or even suggest another method than drilling–if they'd tell me the problem."

Some improper questions are born of commercial security, some of thoughtlessness, some of ignorance. But, regardless of the reason, they result in poor answers.

If you want the right information, be sure you ask the right questions. It's as simple as that. It isn't enough to tell the recipient *what* you want; you must also explain *why*, at least to the maximum extent you can. Your guess at what you want may be wrong, your knowledge faulty or outdated. Your question may be too terse, too much based on your own estimate of what you need or your own unwillingness to admit how little you know. So the answer you get may be incomplete or even incorrect, unless the answerer is smart enough to read your mind or is exceptionally skilled in the field of your question.

The same point applies when you quote the answer, particularly if you're an intermediary. Be sure you give *all* of the answer, and without interpretation. You've seen what can be done with a criticism of a theatrical production by quoting only part of the comment. (Critic's comment: "If you convince me that this is a good play, I'll go back and suffer through it again." Quote: "A good play, I'll go back again.") This is called quoting out of context–it conveys the wrong impression. So does any bad quote anywhere.

And so does any bad question.

NUMERICAL CONTROL DOMINATES MACHINE-TOOL SHOWS

VAST: looking down one leg of Chicago's Navy Pier—scene of the the Production Engineering Show.

EDITORS: Product Engineering had six in Chicago to cover the machine-tool shows. From left: Frank Yeaple, Nick Chironis (standing), Ford Park, Joe Kelleher (kneeling). Editor E. J. Tangerman was at a conference, Richard Koff is behind the camera, here and above.

CHICAGO—Numerical control was the high spot of the machine-tool shows this year, just as ceramic tooling was five years ago. More than 100 machine tools thus equipped were shown. These included foreign units as well as American. In general, also, the largest machines exhibited were a little smaller than the largest machines of five years ago—partly a function of the short time for installation and relocation made necessary by coming so soon after the Republican National Convention in the Amphitheatre—while many makers known for smaller machines showed larger sizes. Refinement of control types and locations, of drives and details, were also evident, but there were few major changes. Consolidations of builders also resulted in a decrease in number of exhibitors, but larger exhibit areas.

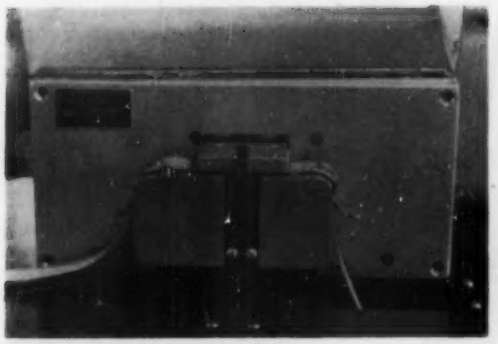
Rigid show rules removed much of the carnival atmosphere—there were no giveaways of gadgets, ornate displays or display gimmicks, at least in the largest of the shows. Though record heat (day after day in the 90s) was not an ideal ambient for the show, exhibitors reported far more interest and actual business than was evident five years ago.

The shows were unusual in that three occurred simultaneously in different locations: the 300,000-sq ft Machine Tool Exposition at the Amphitheatre, the 100,000-sq ft Production Engineering Show at the Navy Pier, and the 20,000-sq ft Coliseum Machine Show (nonmembers of the NMTBA and foreign). Together they resulted in the largest exhibit of machine tools, presses, accessories and components in the world. For the design engineer, the Navy Pier show included the greatest amount of interesting material, although the other shows provided case studies of applications.

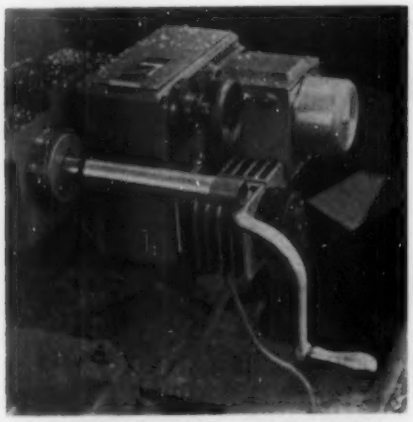
Increases of speed, feed and power were quite common, as well as applications of automatic feeding, locating, tool adjustment and like elements of automation. Surprisingly, the large planer, shaper and planer-type millers, obviously necessary to produce major components of the machines exhibited, and justifying the old claim that machine tools are the only machines able to reproduce themselves, were conspicuous by their absence. Lathes, drills and their variants, and millers dominated the Amphitheatre Show.

Our editors made booth-by-booth visits to seek out design changes that suggest adaptation in other fields. These are presented in following pages.

WHAT THEY'RE OFFERING IN ELECTRICAL CONTROLS



DOZENS OF PINS in this 'block reader' electrically decode standard punched tape many rows at a time.



POWER PACKAGE for machine-table drive has servomotor and decoder unit that interprets block-reader signals directly. No memory storage is needed. Block reader and control are made by Wang Laboratories Inc.

■ Marriage of brute power and sensitive numerical control is an accomplished fact on machine tools. Over 100 different tool-and-control arrangements—each a ready-to-work production unit—were shown, and they stole the show.

Looking behind the scenes, there are many new design principles that can be easily applied elsewhere than on machine tools, and most are available as reliable hardware.

It is usually easier to measure and control machine-tool position with electrical elements, and it follows that most of their power elements are electrical too. Even where hydraulic power cylinders or motors are chosen in preference to electrical ones—they give better system "stiffness" and higher torque-power ratio—the associated controls are often electrical because they are more convenient. But there are exceptions and some of the novel controls described below have nonelectrical features.

Punched tape is the generally accepted way to supply coded input information to machine tools. Although less versatile than magnetic tape, it's easier to handle, can be read visually, can be altered or corrected with simple equipment.

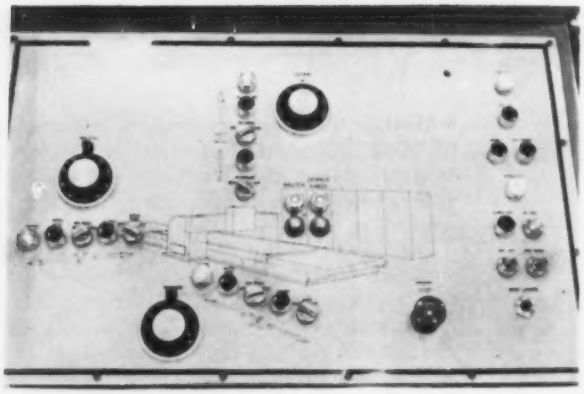
Most manufacturers have standardized on 8-channel punched tape. One version has aluminum foil bonded between two strips of Mylar, and cannot be ripped by any normal means. It can be crumpled, bent and twisted, yet operates perfectly when put through tape-reading equipment.

Electrical and pneumatic tape-readers are available. Electrical readers are common and have conducting fingers that make contact through holes in the tape. Pneumatic readers use low-pressure air (about 3 psi) valved by the punched holes (or absence of holes), and have pressure switches to pick up signal. Pneumatic readers keep tape clean by blowing out holes.

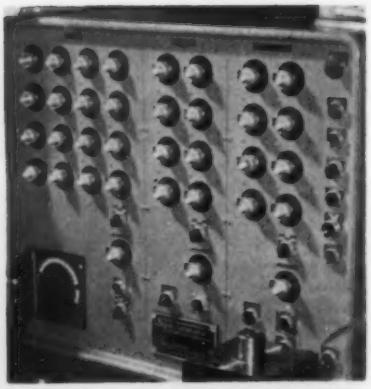
Punched tape can be read sequentially (one row of holes at a time) or in blocks (many rows simultaneously). Sperry Gyroscope of Canada has a pneumatic block reader that transmits enough information in a single block (one step of tape) to complete a whole sequence such as drilling a hole. Wang Labs accomplish same with an electrical block reader (2 photos at left). Sequential reading is

text continued on page 39

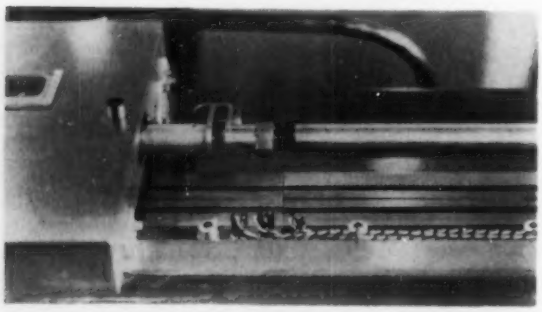
VISUAL READING with fine accuracy is possible with Vernac optical readout made by Simpson Optical, Chicago. Many machine tools have this installed as accessory equipment—with a linear scale (rulings too small to be seen by naked eye) affixed to the moving machine table.



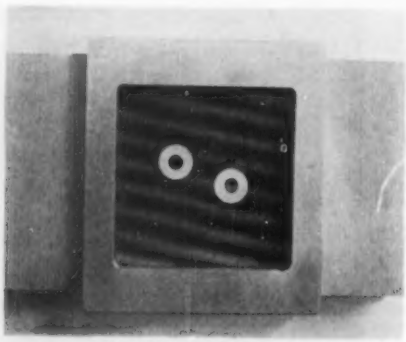
LOGICAL "LOGIC" PANEL of Ekstrom-Carlson milling machine shows three planes of movement in easy-to-understand isometric pattern.



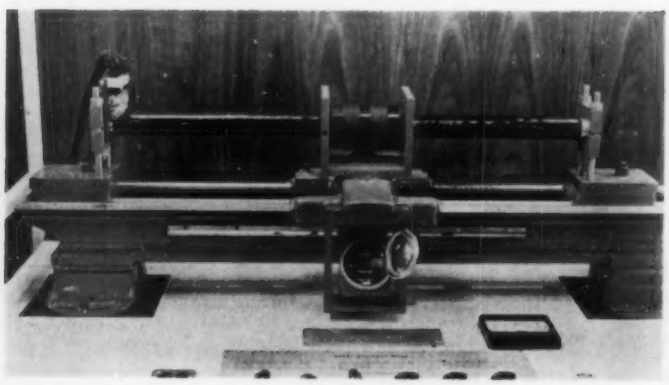
SIMPLE INSTRUCTION WHEEL at lower left carries replaceable, coded metal keys—their function is printed on tab so operator can arrange desired sequences. Photoelectric cells read code automatically to control machine. Dimensions and feeds are set manually in sequence with knobs shown. Control is made by Specialties Inc.



THREE-CYCLE SCALE on new Farrand Inductosyn (linear resolver) covers coarse through fine positioning with accuracy of about 0.0001 in. Three patterns of copper conductors on glass plate give cycle lengths of 400, 10 and 0.1 in.—eliminating auxiliary rotary resolvers usually needed for coarse or medium positioning.

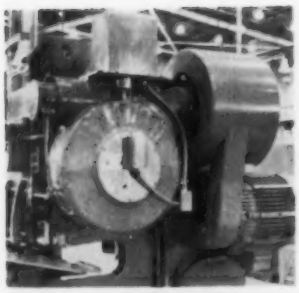


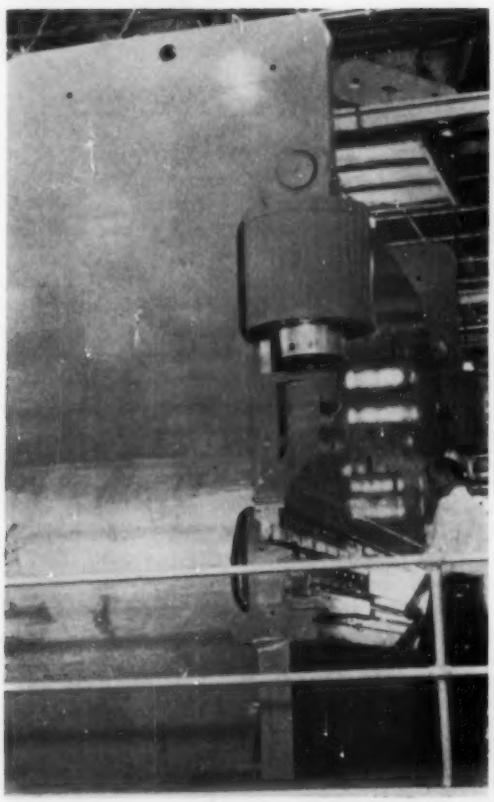
INTERFERENCE PATTERN of light-and-dark (Moire fringes) results from two identically ruled scales being superimposed slightly askew. Circles show locations for photoelectric cells. Fringes move directly with slide, except at a magnified rate, transverse to slide motion. Picture is of inked-paper model only; actual scales (Ferranti Co) are ruled on glass, and are not easily visible by eye.



INCH-BY-INCH SCALE on new Square-D Co linear resolver for numerical control (Rapac Control) has repeatability of about 0.0005 in. Coarse, medium and fine positioning are obtained without auxiliary rotary resolvers. Design has taps (on main resolver windings) every inch, and external switches select the desired terminal. For fine and medium positioning, slider senses induced voltage (transformer effect), giving output signal of zero to 0.5 v when movement varies from null to 0.7 in. on either side of null (direction determines polarity). Output voltage is zero when position is reached.

MILLIONTH-SEC FLASHES of new strobelight (lower of these three photos) introduced by General Radio make possible clear visual observation—in brilliant white light—of almost any cyclic action, including machine vibration and tool-cutting action. Photos at right and far right taken with ordinary 35mm candid camera (show stopped motion of relay operating at 2000 cycles per min., and chattering cam at 3000 rpm.





ELECTRICAL-VS-HYDRAULIC POWER question is easily answered when application is press-brake. Electric-motor-driven flywheeel and linkage (small photo at left) stores just the needed energy; releases it with exactly the proper timing (to bend or shear plates of known dimensions and strength). However, if plate characteristics will not always be similar, then choose the hydraulic cylinder version (large photo, left) —it has constant force at all points in cycle.

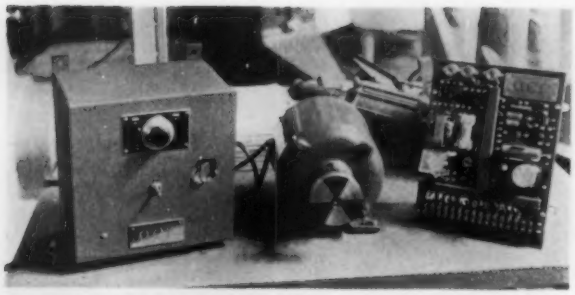
text continued from page 37

slower, and machine control needs a memory device to accumulate enough information to perform a single sequence unless tape and reader are extremely fast (perhaps using photoelectric devices) compared with speed of machine tool.

Automatic or manual control? Many manufacturers answered this question by ingenious modifications of one system or the other. For example, the novel 'instruction wheel' and positioning knobs (above, left) eliminate need for punched tape.

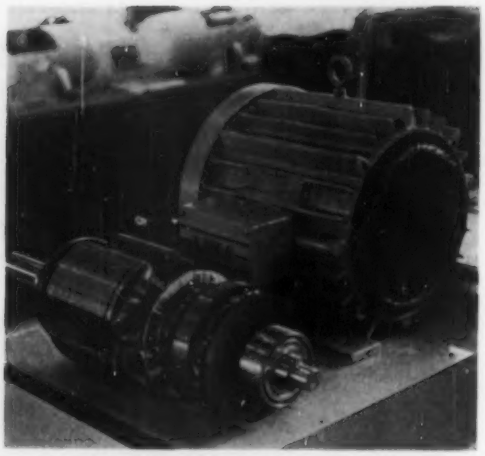
Another control has metal strip instead of punched tape. Strip is indented in prearranged code, and sensors interpret code automatically. Each strip has enough information to machine a part.

Abacus beads may have prompted design of one unique system. Adjustable stops, locked into position on paral-



DC-MOTOR REVERSING without contactors is possible in this brand-new control by ACF Electronics. Silicon controlled rectifiers triggered by a special magnetic device reverse current flow from full forward to full reverse, with no moving parts in the control. Speed can be reversed instantly or controlled at any intermediate speed. Motor in photo is 1/3 hp (1200-0-1200 rpm) but larger motors within rating of silicon controlled rectifiers are possible (largest contemplated is 5 hp.). Transient braking pulse in control helps motor reach reduced speed quickly, overcoming motor inertia.

SIX-SPEED 30-HP MOTOR can produce constant output hp regardless of speed chosen. Two windings plus built-in gearbox with solenoid-operated hydraulic shifting mechanism change output-shaft speed quickly and smoothly, even while motor is running. Control is remote, runs on 60 cps, 200 v, 79 amps at 1800 rpm; or 440 v, 82 amps at 1200 rpm motor speed. By Lima Electric Motor Co. Inc.



SMALL AC GENERATOR can be driven as accessory on portable equipment such as road-building or farming machinery. Rectifiers on plate in center of shaft, eliminate need for slip rings between exciter and generator. Inherent control of generator output keeps voltage relatively constant despite load changes (10% regulation) and can drive ordinary polyphase squirrel-cage motors. Generator is rotating-field synchronous unit. Exciter rotor is, in effect, the secondary of a rotating current-transformer induction-frequency converter. Increased load current causes immediate increase in exciter secondary output voltage, which is rectified and applied to generator field winding. Made by Lima Electric Motor Co Inc.

lel rods, establish sequence of machine operation by actuating limit switches.

Digital positioning knobs replace (or augment) punched tape in some controls. Dials are turned manually until indicator or pointers read desired dimension—say 12.050 in.—and the machine table moves precisely to that position when start button is pushed.

Position transducers in automatic controls halt table or tool movement at exact desired point. A wide variety of approaches to this positioning problem—some novel—were exhibited.

. . . **Rotary resolvers** (conventional synchros) are still used on most automatic machine tools. They are geared to lead-screws or racks in various ratios to give coarse, medium and fine adjustment. Resolvers of any type are electromagnetically coupled (transformer effect) and have no sliding contacts to wear out. Limitation of rotary type is in the possibility of error due to backlash and other inaccuracies in gearing.

. . . **Linear resolver** is stretched-out version of rotary type. It can be mounted directly on table or base of machine tool, instead of on rotating lead screw or pinion, so lead-screw accuracy need not be so close. Two unique linear resolvers (see bottom photo, p 38) were introduced for first time at show. Both eliminate need for separate coarse and medium resolvers.

. . . **Linear optical** gratings are ruled lines on a glass plate. Photocells detect dark-light fringes when one plate (slider) is moved along identically ruled baseplate. Bendix Corp now offers such gratings (under Ferranti license) for machine-tool controls. Accuracy is about 0.0005 in., obtained with spacing of about 500 lines per in.

. . . **Two new motor packages** were introduced at the show. One, by ACF Electronics, is a reversing control with no moving parts. Other is the 6-speed drive by Lima Electric Motor Co (see photos).

Unanswered still is the old question of electrical vs hydraulic power—each job still has to be evaluated on basis of its own special requirements. Two lower photos, p 39, give answer for one application—a press-brake. ■

PNEUMATICS AND HYDRAULICS — a lesser share?

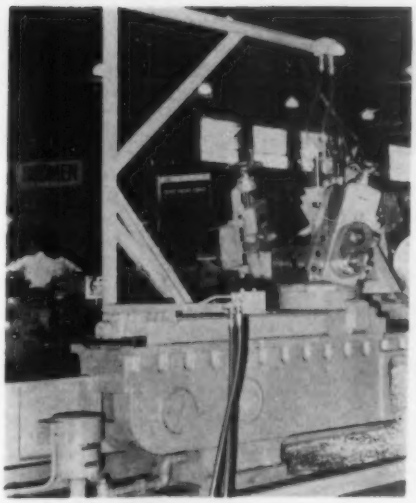
■ Total sales are up, applications are widening, but somehow hydraulics and pneumatics haven't fulfilled the promise of the 1955 show. Then, hydraulics seemed the best answer for machine-tool muscle. Today, direct-current drives, two-speed alternating-current drives, even single-speed ac drives used with clutches and brakes, are giving the traditional piston and cylinder or hydraulic motor some very serious competition for their share of actuator applications.

It is relatively easy to see why. Tape readers are almost exclusively electrical. Servovalves needed to transform electrical signals into fluid flow are generally slower responding than all-electronic amplifiers or thyratrons used for dc drives. Long hydraulic lines and expansion in flexible hose sections can play hob with high-frequency servo response. Hoses connected to movable sliders make a rat's nest out of an otherwise clean-looking machine. Heat dissipation—particularly in high-horsepower applications—can be a problem. Pumps are noisy.

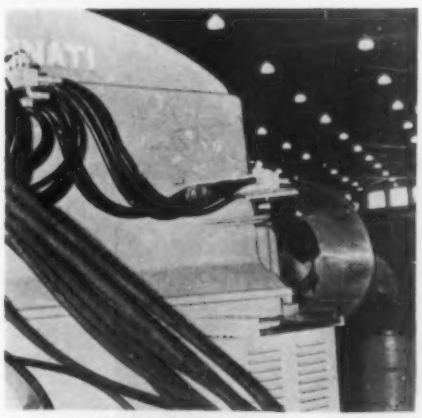
But such problems can be solved and the basic advantages for hydraulics still remain. Fluid motors are much smaller than their electrical counterparts. High-torque low-speed (even to stall) are possible without damage to cylinders or motors. There is less inertia to start or stop.

Experience with one system or the other, price difference, even a rumor, is enough to shift the balance. One manufacturer exhibited two models of the same machine—one with hydraulic, the other with electric drives. "Whichever the customer wants . . ."

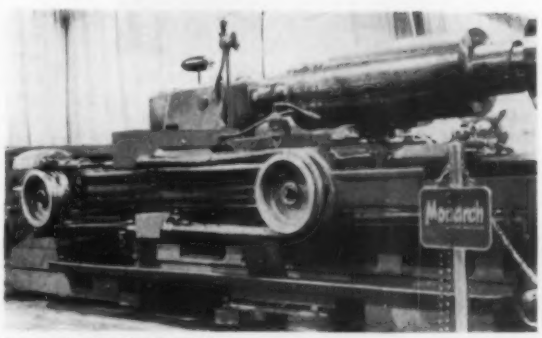
One thing the customer definitely does not want is high pressure. Five years ago the industry operated at 200- to 750-psi working pressures. Today, systems cluster around 750 psi even though the pumps and valves have been designed for 1500 to 2000 psi. Apparently the advantages of small size and quick response are not enough to overcome the risk of spraying a customer on his tour through the plant.■



Gisholt Machine Co

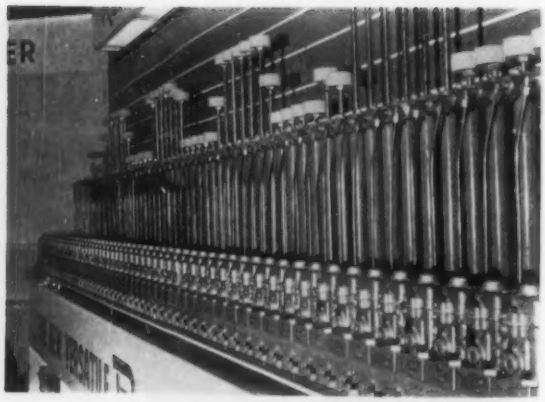


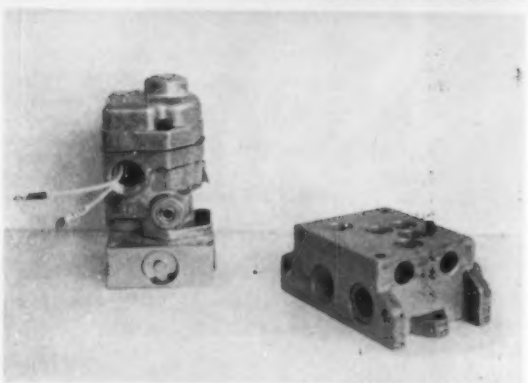
Cincinnati Milling Machine Co



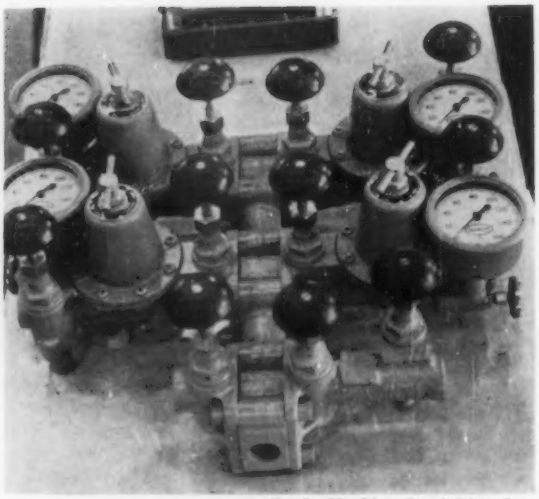
Monarch Machine Tool Co

PIPE AND HOSE LINES sprout like weeds when added as an afterthought. Integrated into a design they either disappear completely or become an unnoticed part of the machine. Note these solutions: Gisholt Machine Co put tubing in a welded frame that reaches over the moving head. Cincinnati Milling wrapped them around strips of spring steel (as did Warner & Swasey, see p 21). Monarch Machine Tool Co brought hydraulic and electric lines to lathe saddle over two sheaves mounted on a free-sliding frame.



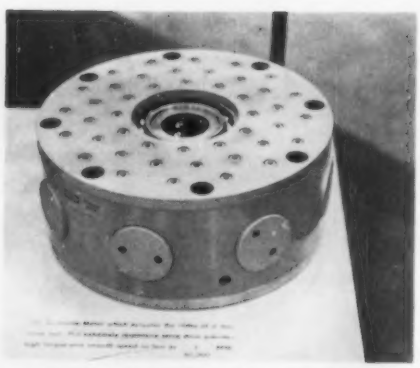


Ross Operating Valve

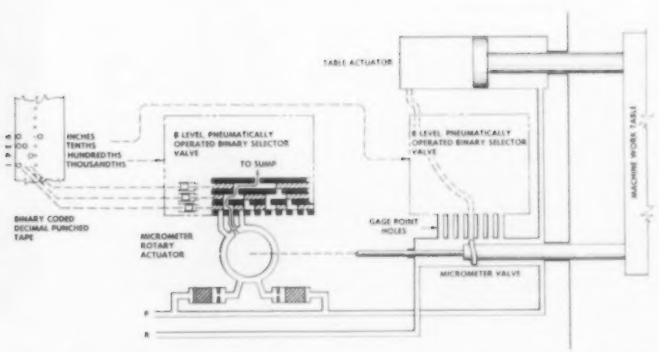


Danly Machine Specialties, Inc.

AIR MANIFOLDS solve the replacement problem—loosen a few screws and the valve comes off in your hand—no pipe fitter, no electrician needed. The Danly Machine Specialties manifold has combined air regulator, gage and blow-off valve mounted to a header bar. Ross Operating Valve mounted sixty 4-way valves on as many single-station manifolds. O-rings seal the connections between manifold and valves, and between adjacent manifolds.



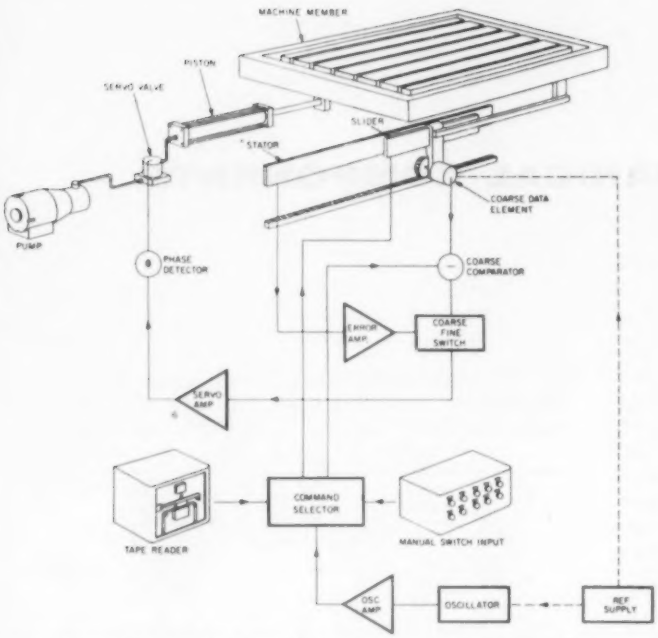
RADIAL-PISTON MOTOR made by Cincinnati Milling Machine Cimtrol Div, is used to drive the lead screw on numerically controlled milling machines. The motor has eight pistons arranged in four opposing pairs. The piston rods end in rollers that push against a two-lobed cam mounted on motor shaft. Thus only torque is transmitted to the motor shaft—there are no unbalanced bearing forces to create vibration in the drive. The motor is speed-controlled to as low as 1/10 rpm (open loop), as high as 500 rpm. It produces 352 lb-in. of torque for 100-psi drop across the motor.



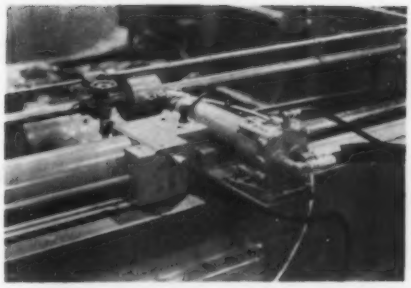
NO ELECTRONICS AT ALL in this one—a pneumatic-hydraulic numerical controller just announced by Moog Servocontrols. Table position is established by the micrometer valve—its piston rides past a series of holes drilled 10 to the inch in the cylinder wall and comes to rest when it just covers a selected hole. Thus, coarse position of the table is established by the appropriate gage-point hole.

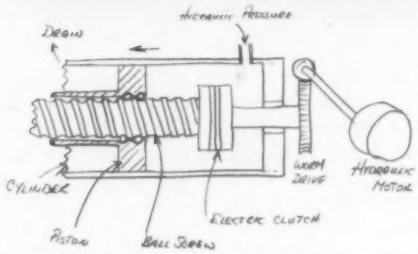
Hole selection is accomplished by an ingenious adaptation of the binary coded signal read from the tape. The tape reader is pneumatic. Each combination of holes in the tape produces a corresponding pattern of motion of a group of metal plates having rows of spaced holes as shown in drawing. The plates block all gage-point holes but one—the selected position in inches and tenth-inches.

The valve piston is slanted and rotatable so micrometer advance can be controlled by a second set of holed plates. Rotation of the piston according to hundredths and thousandths, as read from the punched tape, provides a claimed position accuracy of under $\pm$ 0.0005 in.; repeatability, $\pm$ 0.0003 in. Complete system sells for under $9000.

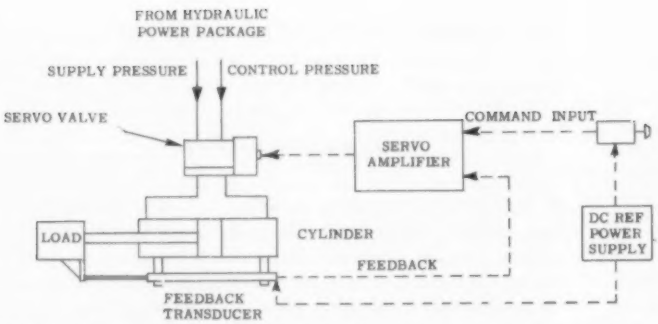


ELECTROHYDRAULIC POSITIONER developed by Sperry Gyroscope of Canada, and applied to jig borers made by several manufacturers, operates on alternating current and uses inductive transducers to establish table location. A coarse-data element brings machine table to within about 0.050 in. of desired position. The inductive transducer then takes over and calls for table motion (powered by a hydraulic cylinder directly—no leadscrew used) until the called-for position is reached within ± 0.0005-in. accuracy and ± 0.0001-in. repeatability. Punched tape is read in blocks 2 in. long (16 lines) so all command details pertaining to one machine motion are read at once.





LINEAR SPEED OF PISTON is controlled here by rotation of a ball screw running the length of a hollow piston rod. Full hydraulic pressure acts across piston during forward stroke. Piston, however, cannot move unless ball screw turns. Thus the small hydraulic motor is the feed speed controller and full piston thrust is available independent of speed. Return stroke takes place at high speed with worm-drive clutch disengaged. Cylinder drives the boring tool of an R K LeBlond Machine Tool Co "Rapid Bore."



SERVO SYSTEM using building-block components is assembled to meet specific application requirements by Vickers Inc. Heart of the system: an electrohydraulic servovalve. It operates on a dc signal and regulates oil flow to hydraulic motor or cylinder accordingly. Load movement is measured by feedback devices reading position or speed. The feedback and command signals (from potentiometer or tape reader) are combined and amplified to complete the loop by sending dc signals to the valve. Accuracy of positioning is claimed less than ± 0.0015 in. Note that this is an all-analog system.

DEPTH OF STROKE is determined by a timer, as is the point at which rapid traverse changes to feed speed, in this Pope Machinery Corp, Double Head, Precision Boring Machine. Oil temperature is thermostatically controlled to within 2°; and flow, hence feed speeds, is set on bleed-off flow-control valves. Stop and speed change locations are then determined by cycle timers—a given number of seconds for a desired stroke—to within 1/16 inch. A mechanical stop is used for more accurate hole bottoming. Both heads can operate at the same time.

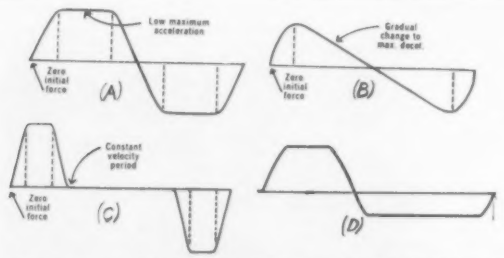
LATEST IN MECHANICAL COMPONENTS

■ The trend is toward specialization and refinement—few items involve new principles. More off-the-shelf items were seen and some old-timers such as O-ring belting and hydrostatic bearings are being used in new ways. In gearing, emphasis is toward automatic inspection systems, and a new gear-rolling machine may lead to more gears being called for of this type. In the miniatures ball-screws are getting smaller, and lubrication systems have more sophisticated warning devices.

BARREL CAMS

Standardized barrel cams now come off the shelf. Already on the market are the plate and groove types. For reciprocating and indexing applications, the cams are available from Ferguson Machine Corp in a variety of sizes, phase angles, stroke lengths—and with any of four acceleration patterns illustrated below. The four:

Modified trapezoid—for light and medium inertia at high speeds. **Modified sine**—for high-inertia applications

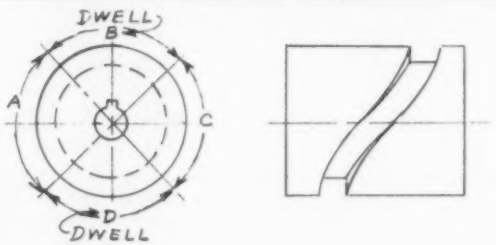


THESE FOUR STANDARDIZED ACCELERATION PATTERNS can now be specified for off-the-shelf cams: (A)—Modified Trapezoid, (B)—Modified Sine, (C)—Modified Constant Velocity, (D)—Increased Deceleration Time.

(heavy loads) at lower speeds. Vibrations caused by elasticity minimized; cam input torques decreased. **Modified constant velocity**—for constant-velocity operations or where cam size must be reduced. Required size is two-thirds that of modified-trapezoid. **Modified trapezoid with increased deceleration time**—for plate or end cams with spring return followers.

Ferguson claims tests proved the superiority of modified trapezoid and modified sine over other types of acceleration patterns.

Timing angles available for barrel cams are 60°, 90°, or 120° rise and fall with two dwells. Cam selection is simplified by consulting tables for cams with required stroke, timing and cam size. Load charts then verify that



Typical Standardized Dimensions

Linear Stroke, in.	Timing, deg			Cam dia, in.
	A & C	B	D	
3	60	120	120	16
	60	120	120	9
	90	0	180	12
	90	90	90	12
	90	0	180	9
4½	60	120	120	16

cam and follower combination will sustain load at desired speed. Reducing the cam size increases the permissible acceleration load.

GEAR-ROLLING MACHINE

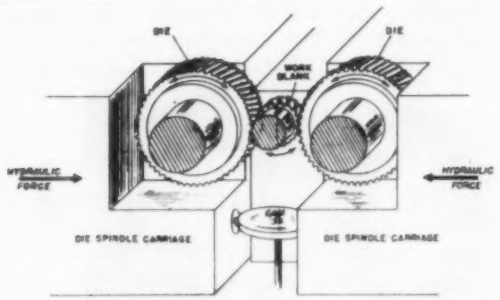
Rolled gears are stronger, smoother. A new Barber-Colman rolling machine finish-rolls gears in addition to rolling splines, threads, and worms from solid stock. In gear rolling, it handles either spur or helical forms, and produces the final tooth form from pre-hobbed gears.

The new machine uses two cylindrical dies (see illustration) and pressure from two opposed hydraulic cylinders to converge on the workpiece. Dies are rotated in same direction and the metal squeezed out to flow into recesses and form the tooth tips.

There's a growing interest in this process because cold rolling offers:

Increased strength—Rolling rearranges the grain into a

stronger structure, similar to forging, and prestresses at the same time. Gears are sometimes 20% stronger. **Increased surface hardness**—Gears are harder and more



GEAR-ROLLING PROCESS employs hydraulic pressure to finish roll teeth of hobbed gears.

wear-resistant. Surfaces have finishes as low as 10 microin (60 microin is more common). **Tooth errors corrected**—Finish rolling tends to correct profile errors left from gear cutting and to reduce lead and tooth space deviations. **Faster production method**—Method also saves stock; tools last longer.

Range of gears (or blank dia) that can be handled with the new machine are from ¼ to 3 in. dia. Pressure angle must be 14½° or greater; diametral pitch approximately 10 maximum.

GEARS CHECKED WITH MEMORY DEVICES

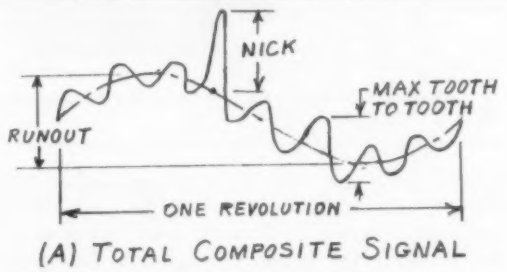
Gear-inspection machine can check nine categories. This completely automatic gear-inspection machine by Illinois Tool can check up to 600 gears per hour for runout, tooth-to-tooth, nicks and size. Additional stations can be added to check bore, wobble, involute profile, maximum lead and average lead errors.

Basic principle revolves around unique design of master gears (some patented), and use of memory devices. Gears are automatically accepted or rejected to prescribed tolerances and sorted into size classifications for mating in assembly. For example, gears for one automotive company are classified into five sizes: 1—mean size, 2—low, 3—high (these three sizes are acceptable); 4—oversize, 5—undersize (these two sizes are rejected). This facilitates assembly of planetary gears because all gears of one class, either high, low or medium, are assembled together, thus avoiding unbalance.

Center-distance variations are transformed by a transducer into a varying electrical current similar to the graph drawn by a gear charter. Signals are electrically separated into errors occurring in each revolution of the gear being

COUNTERS ON FRONT PANEL of new gear-inspection machine count gears which are automatically separated into: good gear, runout (rejects), nicks, tooth to tooth, oversize, undersize.

checked—such as caused by runout, wobble, lead—and errors which occur when each tooth goes in and out of mesh (caused by involute, lead and spacing irregularities). A nicked tooth appears as a high "pip" in the latter signal.

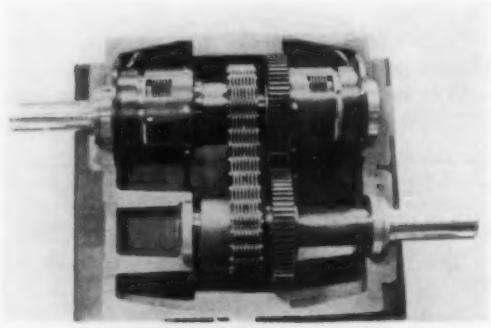


ELECTRICAL SIGNALS fed to amplifier.

continued, next page

HIGH-SPEED REVERSING

Reversing transmission uses gear-belt combination. Designed for applications requiring high-speed reversing, positioning and sequencing of loads, this transmission produced by Airborne Accessories Corp employs gears to drive output (lower shaft in photo above) in one direction, and a silent belt to reverse. Shifting is done through two opposing magnetic clutches. Speed can be reversed in less than 0.2 sec.

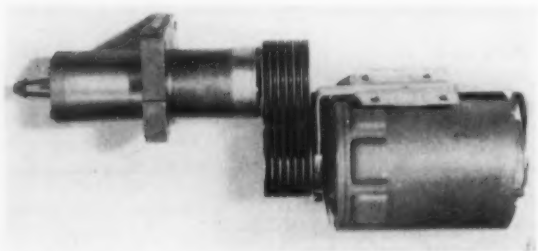


ONE-TO-ONE REVERSING TRANSMISSION employs gear-belt combination two actuated clutches.

Motor operates constantly at rated speed in one direction. When clutch at right is energized, the drive operates through gear train—belt runs free. Switching to clutch at left causes drive to operate through belt drive and cuts out the first clutch—gears now run free. Rated power is 5 hp at 1750 rpm. Gear ratio is 1:1. Max output torque is 250 lb-in. Weight is about 60 lb.

O-RINGS REPLACE BELTS

A new job found for O-rings. The trick of using an O-ring in place of a belt to obtain a low-cost belt drive, as in toys, is not new. But here's an application where precision in cross-section—not cost—is the prime factor.



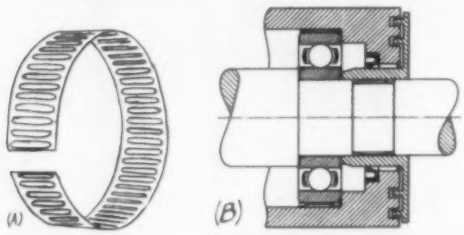
SIX 5/16-IN.-DIA O-RINGS couple 3-hp motor to precision spindle.

Application: Brown & Sharpe's new "Micromaster" surface grinder. The motor is coupled to the spindle through a belt to avoid vibrations. Multiple V-belts were difficult to obtain with a high degree of constant cross-section along the belt. This caused some unbalance. Specially ordered O-rings filter out almost all motor vibrations and add none of their own.

The 6-ring drive illustrated here handles 3 hp with a 50% overload. Seven O-rings transmit 5 hp. Sheaves have circular arcs approximately 0.005 in. to 0.010 in. greater in radius than the O-ring radius. Sheave radii can be made more oversize but this cuts power and life.

RING GIVES INTERFERENCE FIT

Tolerance rings retain bearings, rod ends. A corrugated open ring made of hardened steel works as a wedging shim between a shaft and its mating part, or a housing and its related part. This avoids need for interference-fit keys or pins when retaining parts such as bearings, rod ends and pulleys.



GERMAN-DESIGNED "TOLERANCE RING" (A) retains in (B) bearing to housing and labyrinth seal to shaft.

These "Star" rings are a German development, but will be produced here by Roller Bearing Co. The rings have good torque transmission power. For a given shaft dia the transmittable torque depends on width of tolerance ring. Hence long hubs are recommended.

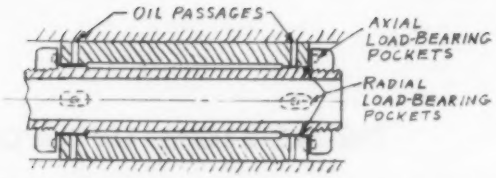
Sizes range from ⅜ in. to 10 in. dia; produced in various widths. An example of what the rings can do: with a pulley fixed on a 2½-in. shaft (+0, −0.001 in.), the bore tolerance can be 0.0045 in. With a 2-in.-wide ring, max transferable torque will be over 9000 lb-in.

The rings can also slip at predetermined torque, absorb shock and maintain a grip between dissimilar metals when temperature changes are extreme.

FOR PRECISE ALIGNMENT

Hydrostatic bearings prevent axis shift. They are keeping the axis of a rotating spindle fixed in space with respect to the housing to within 5 millionths of an inch—spindle is part of the headstock of Brown & Sharpe's new universal grinding machine and makes it possible to grind a part "round" to within 10 millionths.

The bearings have four diametrically opposed pockets at each end, each approximately 1 in. wide by 2 in. long, which are fed by high-pressure oil. Slightest off-axis movement of the spindle builds up pressure in the pockets on one side and reduces pressure in the opposed pockets. This fast buildup prevents off-axis movement. End-wise shift of the spindle, or "end camming," also is prevented—



FOUR RADIAL POCKETS at each end of this hydrostatic bearing keep shaft in line within 5 millionths.

to less than 10 millionths—by annular pockets.

Pockets and grooves are supplied individually with oil through the bearing sleeve. Oil is held to room temperature to avoid thermal distortions, and its pressure of 450 psi results in a high radial stiffness (a desirable factor) of 2,700,000 lb/in.—in excess of that obtainable with practical ballbearing designs. Total radial load that can be carried is about 750 lb. Max workload is 200 lb.

SPECIAL BALLSCREW

Subminiature ballscrew operates switches. The unit has a $\frac{3}{32}$-dia screw and special ballhead. This is $\frac{1}{2}$ the diameter size of $\frac{3}{16}$ produced and designated "miniature" several years ago by the manufacturer, Saginaw Steering Div—hence the "subminiature" tag.

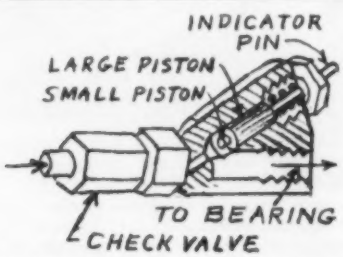
Ballscrews efficiently convert rotary to linear motion,

thus permitting smaller power forces. This subminiature size has been developed to operate a switch when driven by a miniature Selsyn motor—and should also prove useful in positioning mechanical devices.

LUBE LEAKS GIVE ALARM

Detects broken line in lubrication systems. Visual on-the-spot indication of a broken or leaking line is now possible by means of this indicator. It also gives a central warning signal at the pump or control system by causing an abnormal increase in oil pressure.

The indicator, designed by Trabon Engineering Corp, is hydraulic and installed just before the bearing tap. During normal operation, lube pressure keeps the piston and its extending pin out as far as possible. Should the line break, the pressure drop allows the piston to drop (showing a retracted pin). This closes off the small entry port. The smaller piston end is now exposed to incoming lubricant pressure from the pump, which must build up pressure to overcome this blockage. This pressure buildup can be made to set off a central warning system.

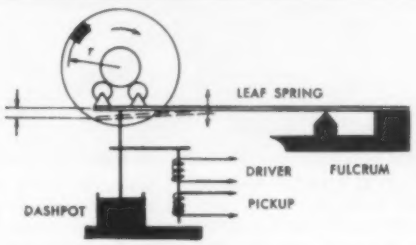


BREAK IN LINE causes pin-end of piston to retract, also can set off central warning system.

ROTOR BALANCER

Balancer for in-place or vibration analysis. It was developed by Stewart-Warner; can determine the amount and location of both kinetic and dynamic unbalance of a rotor while the rotor is rotating "in place."

Centrifugal forces induced by unbalance bend the flat



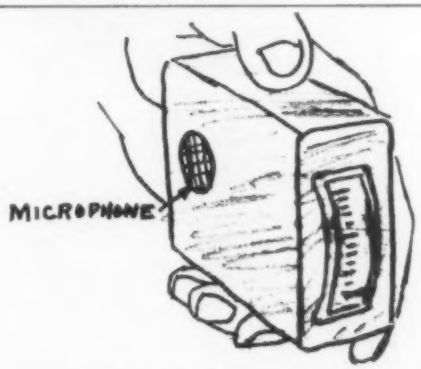
UNBALANCE causes centrifugal forces which bend flat spring in this dynamic balancing machine.

spring downward once each revolution. Spring amplitudes are highest when the system is rotated at critical speed. Thus, by analyzing the rotor during critical speed, very minute amounts of unbalance are detected.

EASY SOUND DETECTION

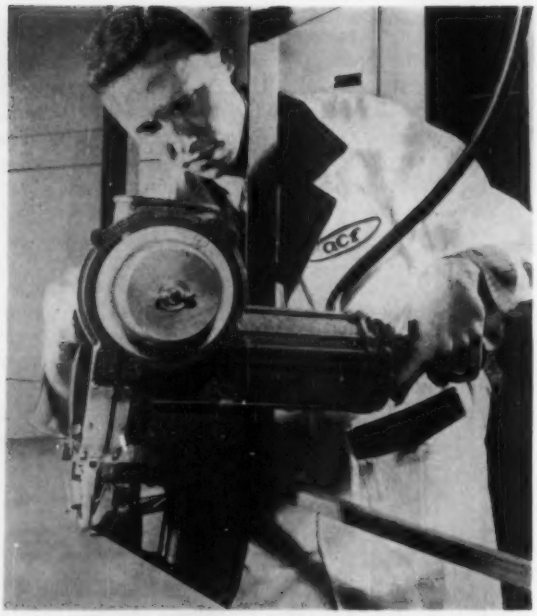
Transistorized sound-level detector was designed to measure noise magnitude quickly and fairly accurately. The portable unit is by the Korfund Co, should find useful work in an engineering test laboratory for on-the-spot analysis of noise sources in test models.

It features a moving-coil microphone (most other porta-



PORTABLE NOISE DETECTOR measures sound level from 40-to-125-lb range.

bles employ crystals), has an input jack for vibration pickup; and can be held in hand, or tripod mounted. ■



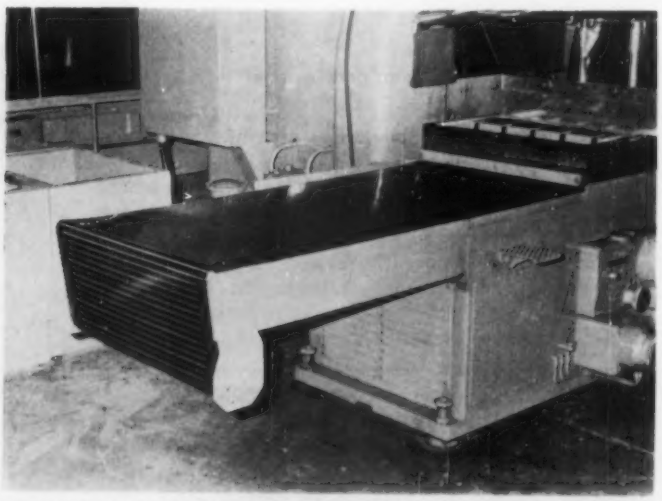
PORTABLE PUNCH RIVETER, developed by ACF Industries, automatically punches a hole, places the rivet, heads the rivet—all in less than two sec. Once the workpiece is inserted into the jaws of the riveter, pulling the trigger punches and dimples a hole. A locating pin, held by light spring pressure, keeps the hole in alignment and later is pushed out by the rivet as it feeds from a pneumatically driven rotating drum holding about 500 rivets. The rivet is fed into the rivet shoe during the punch stroke of the piston. A quick turn of the hand grip actuates a detent that arms the device for heading. A second trigger-pull places and heads the rivet, which may be either flush- or round-head type. Riveting machine weighs 50 lb, operates from a cable-type balancer for overhead suspension or from a bench fixture.

PLASTICS INVADE

■Machine-tool builders are finally beginning to recognize plastics as engineering materials with uses beyond the usual control knobs, pushbuttons, nameplates, and inspection parts. Examples of this growing awareness include the following:

1. Covers, housings, and access doors made from fiberglass-reinforced plastic (FRP) remain the application area where largest volume of plastics is found. Two builders, Cincinnati Milling Machine Co and Gisholt Machine Co, have found places for reinforced plastics in almost all of their latest machines. Both have had their interest sharpened by captive manufacturing facilities: Cincinnati with its Cimastra Div uses the new wet slurry process (*PE—Feb 22, p 52*); Gisholt with its Masterglas Div uses air preforming techniques (*PE—Mar 28, p 74*). A number of other builders use some reinforced plastic housing, but express a growing preference for cast aluminum. They cite rippled surfaces, poor fit-up to mating metal parts, high mold costs as reasons for declining interest in FRP.

RUBBERIZED FABRIC BELT travels on knurled pulleys to drive the two centering wheels on this gravity feeder for miniature ballbearing tracks. Entire feeder is placed into oil-mist chamber of Model B Centalign made by Bryant Chucking Grinder Co. Ring blanks feed down plastic chute at right, to a supporting shoe. Two centering wheels, far right, complete the 3-point support and turn to rotate the blank as the inside track is ground. Oil-mist environment required this particular combination.



NEW-STYLE "ROLLER BLIND" COVER to protect machine ways gets a tryout on Cincinnati's Hydrotel die sinking machine. Here, a rubberized cloth has 1-in.-wide steel strips bonded in place. Cover is attached to worktable, and winds up on driven roller (foreground) as table moves to left. Chips fall off cover as cover passes over upper free roller. Cover on opposite side (not shown) unwinds simultaneously. Steel stripping prevents chips from imbedding in rubber and supplies a reinforced, flat surface that adds to workspace.

2. Bearing surfaces made from reinforced phenolic laminates were standout features on a number of tools —for example, some of the vertical milling machines by Kearny & Trecker Corp, which finds that a combination of rollers bearing on phenolic laminate way-inserts reduces scoring, simplifies replacement. L & J Press Corp replaced bronze slider plates with phenolic laminate on its heavy-duty open-back inclinable presses. Running against cast iron gibs, the plastic plates are said to hold tolerances better over longer periods. These 125-ton presses also use phenolic laminate seats in a novel ball-and-socket joint that replaces the conventional wrist-pin arrangement for driving the die head. Experience to date under heavy impact loading shows the phenolic seats flow much less than bronze seats.

3. Nylon appears in a number of outstanding applications. In coating form this wear-resistant material is applied by Landis Tool Co to many stock-handling accessories such as rollers, hooks, and stops. Landis, like a surprisingly large number of exhibitors, is specifying nylon tubing for hydraulic and pneumatic lines where pressures and temperatures are moderate. Main advantages over conventional hose: smaller diameter allows closer spacing; its stiffness needs less support and keeps it in a given plane when flexed—so adjacent lines in different directions do not tangle.

Rising costs of large castings, particularly in low quantity, are apparently forcing many machine-tool builders to weldments. This is not new with builders of specialized one-of-a-kind machines—but now, manufacturers are thinking in terms of weldments on standard models. With rolled-plate prices holding firm, R K LeBlond Machine Tool Co, for example, finds it's much cheaper to design the feet for its standard lathe line as weldments. Other builders are constructing machine frames by welding to gain simplicity and easy access to all components. A good example is the Cincinnati Filmatic transfer grinder shown in accompanying photos.

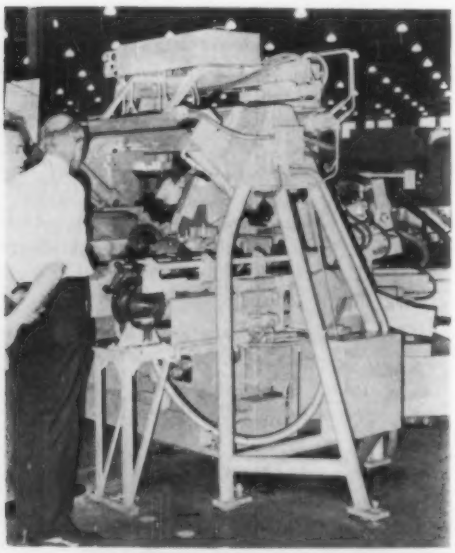
Timing belts are due for a new look shortly, with the

continued, next page

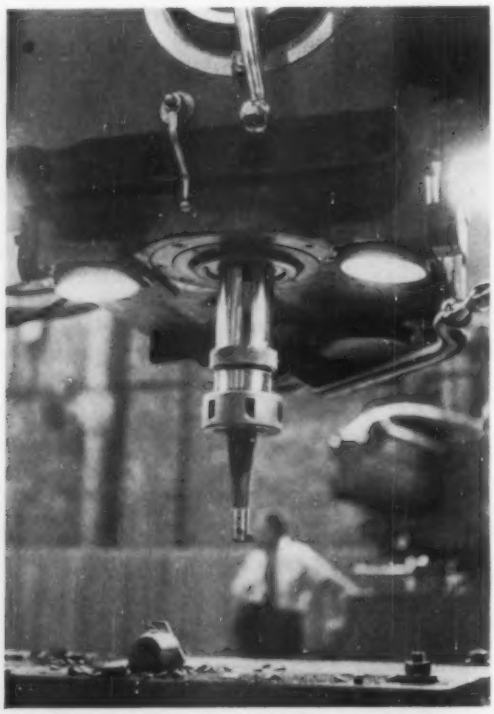
PLASTIC HOUSINGS continue to be featured on a number of machine tools. Both machines here show different approaches. Above left, Gisholt uses fiberglass-reinforced plastic for the window frames on its magnetic tape-controlled turret lathe—and chooses to emphasize them by pigmenting a contrasting color. But Cincinnati chooses to shape its FRP plastic parts like surrounding castings and finish both types of parts identically—as shown on the die sinking machine pedestal at right. Most other tool builders follow the practice of Cincinnati on this point.

US Rubber Co introducing three new material to lower cost and improve performance. Conventional construction is neoprene-reinforced with either stainless wire or modified-rayon cord, and faced on the tooth side with nylon cloth. Use of DuPont's Hypalon, a chlorosulfonated polyethylene elastomer, will boost continuous operating temperature to 250 F, intermittently to 300 F, according to US Rubber engineers. Also available shortly will be all-molded "timing" belts made from urethane rubber. Molded-urethane belts are reported to have better shear strength, more closely controlled thickness, and about 20% lower cost than conventional neoprene-fabric timing belts. Molded PVC belts are currently being evaluated.

The recently-developed ceramic shell process for investment castings is opening the way to several further innovations. The thin shell makes it possible to selectively cool different parts of the casting, thus putting grain refinement where it's needed for maximum properties,' according to engineers at Hitchiner Inc where this technique is being developed. Other experts at the show predicted that the ease of handling provided by the ceramic shell, combined with plastic patterns for greater precision and ruggedness, will lead before long to a nearly automatic investment casting system. ■



WELDED 3-D A-FRAME on Cincinnati transfer machine for grinding steering-knuckles allows easy access to all components of the machine, besides supporting transfer mechanism. Welded from heavy tube stock, this design is cheaper than a cast frame, allows easy conversion to another job.



LIGHT WHERE IT'S NEEDED—a feature of these two machines, both large enough to cast heavy shadows on workpiece under conventional factory lightup. Taking a cue from airline passenger lighting, Carlton Machine Tool Co incorporates multiple spotlights (above) in the spindle housing casting for its radial- and bridge-type boring and drilling machines. Ekstrom, Carlson & Co includes a kitchen-type fluorescent ring lamp around spindle of its open-side profiling machine at right.

practical approach to FRICTION COEFFICIENTS

It's difficult to analyze all the factors affecting friction of sliding parts—and the final answer may still be wide of its mark. Here the author has built a general table of friction coefficients and shows how to modify them to get the values you need.

ERNEST RABINOWICZ
Lubrication Laboratory, MIT
Cambridge, Mass

It is easy to go astray with coefficients of friction. Handbooks list them for some combinations of materials, and searching the literature will reveal more. But conditions under which the values were obtained are usually not given —and when they are, they seldom fit your specific test conditions. Furthermore, when the product leaves your test lab it runs into still different conditions. Result: the quoted value may be off by from 25% to as much as 200%.

The approach here is general, but more practical. It tabulates coefficients for broad classes of materials and conditions, and then shows how to modify the values so that they will allow for the effects of contaminants, velocity and temperature that will be met in actual service.

THE REAL AREA OF CONTACT

Surfaces of engineering materials generally have roughness values ranging from about 1000 down to about 1 microinch (0.000,001 in.). Even 1 microin, however, is over 100 times as great as typical atomic diameters—usually from 0.003 to 0.01 microin—so on an atomic scale, all surfaces are extremely rough.

When two such surfaces are pressed into contact, only the tips of their most prominent protuberances (asperities) actually touch. Total area of real contact is therefore so small that stresses at the contacting points almost invariably exceed the yield strength of one or both materials, and plastic flow occurs at those junction points. This has a double effect: increases size of the individual junctions; brings more junctions into existence.

Plastic flow stops when pressure at junctions falls to a value known as penetration hardness of materials—about three times' yield strength of the material in uniaxial compression. An equation can be written connecting real area of contact A_r, load W, and penetration hardness p of the weaker material:

$$W = A_r p$$

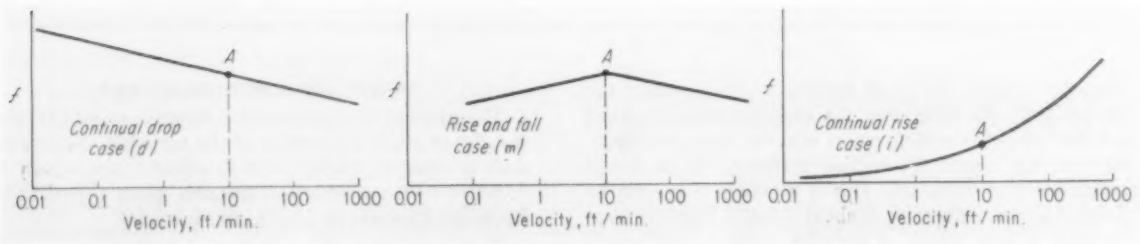
The real area of contact is independent of, and usually much smaller than the apparent area of contact; also, such friction phenomena as coefficient of friction are almost independent of size and shape of the apparent area of contact.

COEFFICIENT FOR CLEAN SURFACES

When clean materials are pressed into contact, strong bonds are usually formed at the junctions. The bonds compare in magnitude to the interatomic bonds within either of the contacting materials. This explains why, when sliding commences, the junctions sometimes shear off in some other plane than the original interface. Shear strength of the junction can therefore be considered approximately equal to bulk shear strength of the weaker material. We can consequently write this equation for the tangential force F required to break off all the junctions and produce sliding, $F = A_r s$. Here, s is shear strength of the weaker material. Combining this and the load equation gives the friction coefficient f_u for uncontaminated materials:

$$f_u = \frac{F}{W} = \frac{s}{p}$$

Because s and p are very similar properties of the weaker material—respectively, its plastic resistance to shear and to normal penetration—their ratio may be assumed the



THREE WAYS that tabulated friction values (points A) can change with variations in velocity.

REPRINTED—Circle P62, inside back cover

GENERAL TABLE OF FRICTION COEFFICIENTS

CONDITIONS	EXAMPLES	VALUES
	FOR CLEAN SURFACES	
General		
Clean, unlubricated surfaces	Steel on silver Leather on wood Nylon on steel	0.5 to 0.3 (d)
Exceptions to above		
Clean, similar metals other than those with close-packed hexagonal structure	Copper on copper Brass on brass Chromium on chromium	1.5 to 0.8 (d)
Clean, similar metals with close-packed hexagonal structure	Titanium on titanium Zinc on zinc	0.65 to 0.45 (d)
Clean, duplex-structure alloys with a soft constituent, sliding against either a hard metal or hard nonmetal	Copper-lead alloy on steel Babbitt on steel	0.3 to 0.15 (d)
Unusual nonmetals		
Rubber on other materials		0.9 to 0.6 (m)
Teflon on other materials		0.12 to 0.04 (m)
Graphite or carbon on other materials		0.16 to 0.08 (m)
	FOR BOUNDARY-LUBRICATED SURFACES (covered by liquid lubricant)	
Ineffective lubricant	Water, gasoline, nonwetting liquid metals	Same as for clean surfaces
Fairly effective lubricant	Refined mineral oils, wetting liquid-metals Also metal surfaces nominally unlubricated but untreated to remove contaminants	0.3 to 0.15 (d) or unlubricated value, whichever is lower
Highly effective lubricant	Mineral oils with "lubricity" additives, fatty oils, good synthetic lubricants	
Metal on metal or metal on nonmetal	Steel on steel Nylon on steel	0.10 to 0.05 (m)
Nonmetal on nonmetal	Nylon on nylon	0.20 to 0.10 (d)
	FOR SOLID-FILM LUBRICATED SURFACES	
Hard metals covered by a thin layer of soft metal	Thin lead film on steel	0.20 to 0.08 (d) 0.12 to 0.06 (m)
Materials lubricated by a layer of graphite or molybdenum disulphide, either alone or compounded by a binder		
	FOR HYDRODYNAMICALLY LUBRICATED SURFACES	
A complete fluid film, produced by the sliding action, separates the surfaces. (This mode of lubrication generally applies only at speeds much in excess of 10 ft/min.)		0.01 to 0.001 (i)
	FOR HYDROSTATICALLY LUBRICATED SURFACES	
A complete fluid film, produced by external pressurization, separates the surfaces		0.001 to 0.000,001 (i) depending on the design parameters
	FOR ROLLING-CONTACT SYSTEMS	
Pure rolling contact. Geometry carefully arranged so that pure rolling motion occurs over the contacting region	Cylinder rolling over a plane	0.001 to 0.001 (d)
Normal rolling contact. Some shear occurs at the contacting region	Commercial ballbearings	0.01 to 0.001 (d)
Arbitrary geometry	Boulder rolling down a hillside	0.2 to 0.05 (d)
	FOR NAKED SURFACES	
Clean metals operated in a good vacuum (10^{-6} mm of mercury or better)		Infinity to 3.0 (d), lower for harder metals
Nonmetals (same conditions)		1.0 to 0.4 (d)

same for a wide variety of materials. Also, neither the applied load, the roughness, the apparent area of contact nor the velocity of sliding enters into the equations; therefore we may expect the friction coefficient to be almost independent of them all. This is generally confirmed by tests—friction coefficients of about 0.5 to 0.3 are observed for quite a wide variety of materials under a wide variety of conditions.

WHEN ARE SURFACES CLEAN?

The concept of cleanliness is difficult to explain because it varies so much with nature of the materials. Nonmetals, such as concrete, wood, nylon or asbestos, can usually be considered "clean" unless deliberately given a good liquid boundary lubricant or a solid film lubricant.

Metals, however, are usually in a contaminated condition (with a subsequent lowering of friction) unless they

have recently been given a new surface by dry lapping, cutting or grinding; by long sliding in the absence of a lubricant; or have been treated with a hot caustic soda solution or other powerful contaminant-remover. If contaminated metal surfaces are slid continuously, the contaminants wear off and the friction rises to higher values.

COEFFICIENT FOR UNCLEAN SURFACES

To what extent do contaminants change value of the friction coefficient? If a contaminant of shear strength s_c (where s_c is less than s) completely covers the contacting interface, f_c, the friction coefficient for the fully contaminated surface, is given by:

$$f_c = \frac{s_c}{p} = \frac{s_c}{s} f_u$$

Thus, the coefficient drops to the degree that the contaminant's shear strength is lower than that of the base material.

Many contaminants, however, do not cover the surface completely (or may have been partly removed by wear during sliding). If a fraction, α, of the surface is clean, then a fraction $(1 - \alpha)$ is covered, giving the relationship:

$$f = f_u + (1 - \alpha) f_c$$

The trouble is, values of alpha can be readily estimated only when very good lubricants are used (α nearly 0) or very poor lubricants are present (α nearly 1). It is ignorance of the true value for alpha that is the main reason for poor "predictability" of friction values.

VELOCITY EFFECTS

Effect of velocity on the friction is usually small. Typically, for every change in sliding velocity by a factor of 10, friction changes by about 10%. The friction table on the opposite page has been arranged so as to give the friction coefficient at a sliding speed of 10 ft/min. Each value is usually followed by an indication whether friction at this point is decreasing as the speed is raised (indicated by the letter d), whether it is increasing as the speed is raised (the letter i), or whether the friction is at a maximum, (the letter m). The three charts on p 51 illustrate these concepts.

Where a (d) is given, lower the friction value by 10% for every factor-of-10 increase in the sliding velocity above 10 ft/min., and raise the friction by 10% for every factor-of-10 decrease of the sliding velocity below 10 ft/min.

Where an (i) is given, the friction coefficient is very low and increases in direct proportion to the sliding velocity.

With an (m), decrease the given value by 10% for every factor-of-10 change in the sliding velocity, from 10 ft/min., in either direction.

Relationship: Static & Kinetic Coefficients

The static coefficient of friction indicates the force required to commence sliding; the kinetic coefficient indicates the force required to maintain sliding. Most tables of friction values give only static coefficients.

Tests have shown that the static coefficient is a function of the time the surfaces have been in stationary contact, and that the static friction coefficient for a time of contact of 10^{-3} sec is also the kinetic coefficient for a sliding speed of 10 ft/min.

For combinations listed in the general table followed by a (d), the static coefficient for stationary-contact time longer than 10^{-3} sec may be obtained by adding 10% to the friction coefficient for every factor-of-10 increase in stationary-contact time more than 10^{-3} sec.

Tables of friction coefficients found in standard compilations generally show the static coefficients as being about 40% greater than the kinetic. Therefore, they are valid for a time of contact of about 10 seconds.

For those sliding combinations in the table followed by an (m) there is no difference between the kinetic and static coefficient because some movement of a stationary system will occur, even on application of a value of the friction force smaller than that corresponding to the kinetic coefficient. In effect, the "breakaway" friction coefficient for such surfaces is equal to the kinetic coefficient for the sliding speed being initiated, or the highest kinetic coefficient reached at some lower speed.

For sliding systems followed by an (i), examine the system on an individual basis to see what the static friction coefficient will be.

EFFECT OF TEMPERATURE

The effects of temperature can be quite marked. In general, changes in coefficient of friction are of the order of 0.1 per 100 deg F, and tend to persist in the same direction for a few hundred degrees. Superposed on these may be "transition temperatures"—at which the friction coefficients change by the large amount of 0.2 to 0.5 over a temperature range which may be as narrow as 50 deg F.

While the direction of these changes is fairly random (friction can go up or down as the temperature rises), as a general rule the changes tend to bring the friction at high temperatures to a value of 0.6 to 0.4 (d). In other words, if the friction coefficient at room temperature is below this level, the friction tends to rise with increasing temperature; if the friction is above this level, the friction tends to fall with increasing temperature.

THESE THREE RULES

For cases not covered by the table on p 52, the following rules give good approximations.

- When conditions are unknown, use $f = 0.3\ (d)$
- For severe sliding conditions, use $f = 0.6\ (d)$
- For mild sliding conditions, use $f = 0.15\ (d)$

For REPRINT of above article, just check P62 on one of the Reader Service cards in this issue.

EDITOR'S NOTE: For more information on friction and wear, see:

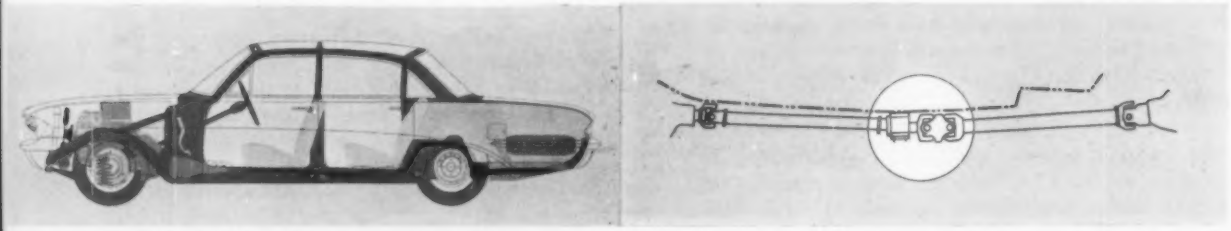
How to Predict Wear Life of Rolling Surfaces, May 9 '60, p 44—New load-stress K factors for various material and hardness combinations simplify life-expectance and calculations for gears, cams, bearings, clutches, and links.

Predict Wear of Metal Parts, June 23 '58, p 71—Presents new design coefficients to account for galling; discusses conditions of lubrication, surface cleanliness and surface cracks, and tells how they affect design.

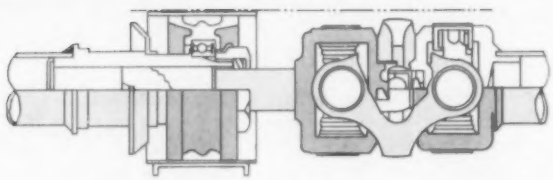
PRODUCT DESIGNS

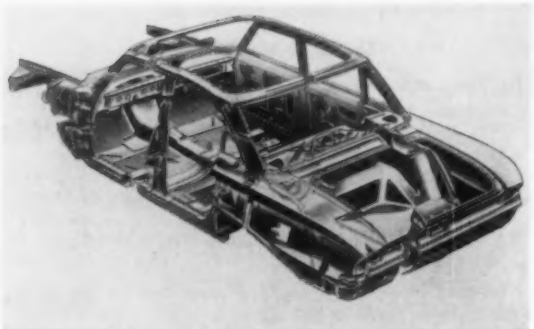
Oldsmobile goes compact too

F-85, the newest Olds, is like GM's newest Buick and Pontiac in that it wraps aluminum around cast iron for its V-8 power-plant.

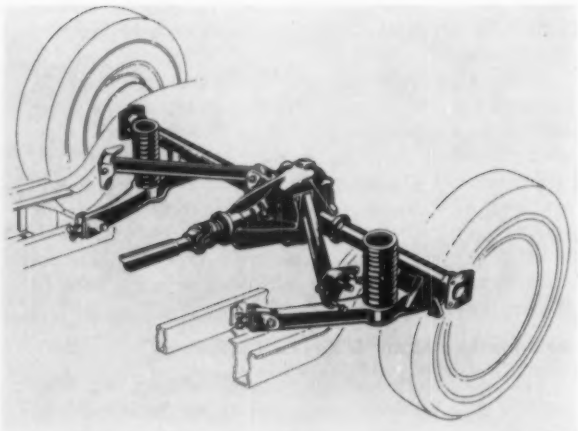


TWO-PIECE DRIVESHAFT, which reduces tunnel height, is shown in phantom view. A central ballbearing pillow block mounted in rubber and a spline joint permit variations in shaft length to accommodate suspension movements. Both halves of driveshaft are joined by a constant-velocity joint. A ball socket in this joint provides support and acts as pilot bearing for relative location. The ball center also divides the imposed angle equally between both halves of the joint assembly. Constant-velocity joint cancels any coupling forces and other irregularities at the center joint, providing maximum shaft smoothness.



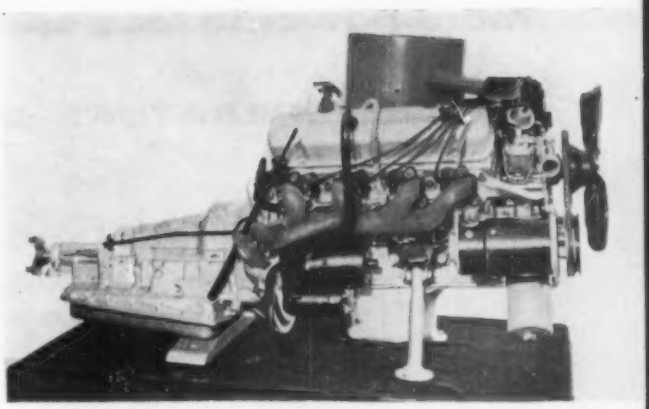


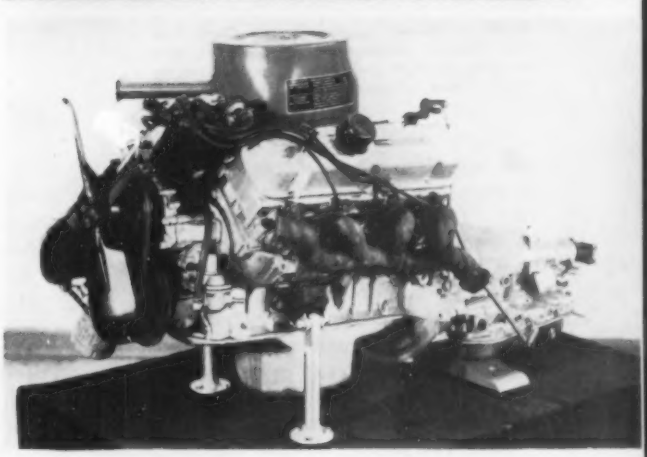
INTEGRAL-WITH-FRAME construction of the F-85 follows the auto industry's trend to unitized construction. Bodies are assembled into a single unit by welding the required sheetmetal parts into a single structural unit. A separate cross-member at the front is assembled to the body-frame rails and insulated from them by rubber.

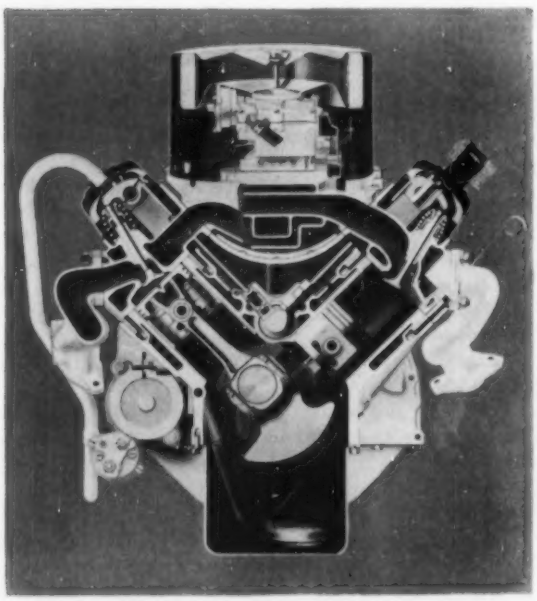


The rear axle and differential are connected to the body side-rails by four rubber-mounted links. The outer links (between frame and axle ends) transmit driving and braking forces, also control vertical stability. The inner links (between differential housing and frame) control lateral stability.

OLDSMOBILE F-85	
Wheelbase	112 in.
Over-all Length	188.2 in.
Over-all Height	52.6 in.
Over-all Width	71.6 in.
Weight (curb)	2695 lb
Tread: front	56 in.
rear	56 in.
No. of Cylinders	V-8
Bore & Stroke	3.5 x 2.8 in.
Displacement	215 cu. in.
Compression Ratio	8.75:1
Torque	210 16-ft at 2800 rpm
Brake Horsepower	155 at 4800 rpm
Tire Size	6.50 x 13
Brake Area	130 sq. in.
Turning Dia.	37 ft

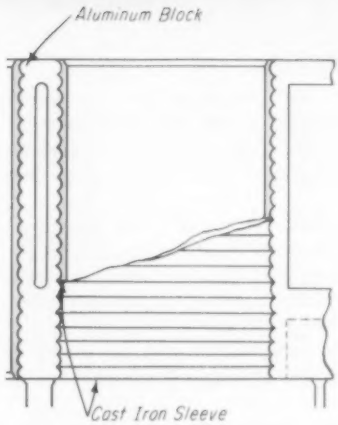






ALL-ALUMINUM V-8 weighs approximately 350 lb and results in significant weight-saving. Aluminum is used for the cylinder block and heads, intake manifold, timing-chain cover, water-pump cover, plus many other small parts. Cast iron cylinder-sleeves are cast in the aluminum block to provide improved wear characteristics. Casting the sleeves integrally provides excellent contact with the aluminum water jacket for improved heat transfer. Sleeves are mechanically lockd in place by circumferential grooves turned in their OD. Casting process is permanent-mold system using sand cores. Cast iron is used for valve guides, main bearing caps and exhaust manifolds, as well as the cylinder liners.

Carburetor cover completely encloses both the carburetor and dry-element air cleaner. This provides complete weather protection plus improved silencing of intake air. The cover mates to a flange atop the intake manifold and is retained by a single wingnut.



PS . . . Oldsmobile's entry into the compact field presents a good insight into the technical relationships which tie GM divisions together. Aside from the dimensional similarities among GM compacts, numerous components and major assemblies are identical or vary only in minor detail. The all-aluminum V-8 used both in Olds and the Buick Special also powers one of the two models of Pontiac's Tempest *(PE—Sept 12, p 64)*. Differences are limited to the pistons, combustion chambers and valves. F-85 is produced by the Oldsmobile Div, Lansing, Mich.

more power in less space . . .

HIGH-TEMPERATURE ELECTRICAL EQUIPMENT

Motors, solenoids and transformers can be uprated by designing them to run hotter. Here are latest developments in the quest for electrical equipment that can stand the heat.

Based on material supplied by J A Clark, Electrical Product Development; D C Griffith, and D P Ross, Research and Engineering Requirements, Tapco Group, Thompson Ramo Wooldridge Inc

A hot electrical device can get rid of more heat than a warm one because of the higher temperature differential. This differential results in better radiation, convection and conduction to the heat sink. Most important at very high temperatures is the thermal radiation—such dissipation of heat increases with about the 4th power of absolute temperature.

But there is a troublesome limitation. Electrical and mechanical properties of ordinary electrical devices deteriorate at high temperatures, efficiency goes down, and service life is reduced from years to perhaps minutes or seconds. The answer is better high-temperature materials, and the curves of properties on facing page show how much progress has been made.

Electrical Conductors

Silver, copper and aluminum have the most suitable conducting properties at elevated temperatures. But it must be remembered that the resistance of each of these metals goes up 400% or more in the range from 70 to 1000 F.

Silver is expensive, but has a special advantage at high temperatures because its oxide reduces back to silver. For copper conductors, cladding with stainless steel or pure nickel helps prevent oxidation in air—important at temperatures over 900 F. However, resistance of a clad conductor is higher than that of silver or copper alone for given diameter, and mechanical terminations are more difficult to make.

For superhigh temperatures (2000 F) it may be possible to use silver or copper contained within stainless steel cladding. The conductor melts, and the solid cladding becomes a pipe. Natural convection inside the cladding will circulate the molten conductor through a heat exchanger, preventing hotspots by carrying away localized heat.

Magnetic Materials

Ultimate temperature limit for any ferromagnetic material is at the "Curie" point, where it loses its ferromagnetic properties. Some materials maintain substantial magnetic capabilities right up to that point, others degrade gradually. Choice depends on the application.

Motors, solenoids and other power devices need magnetic materials with high flux densities and relatively independent of temperature. Vanadium Permendur (vanadium-iron-cobalt), and Hyperco-27 (iron-cobalt) are suitable to 1000 F and higher.

Core materials for magnetic devices should have low coercive forces, and other special magnetic characteristics such as abrupt (square-loop) change in magnetic flux. Grain-oriented materials such as Supermendur (vanadium-iron-cobalt) retain these characteristics even at high temperatures. However, square-loop magnetic material can lose the orientation of its grain structure if stressed mechanically. Therefore, the wound cores should be placed in cushioning material such as powdered mica or magnesium oxide. This prevents damage when the core expands thermally at high temperatures.

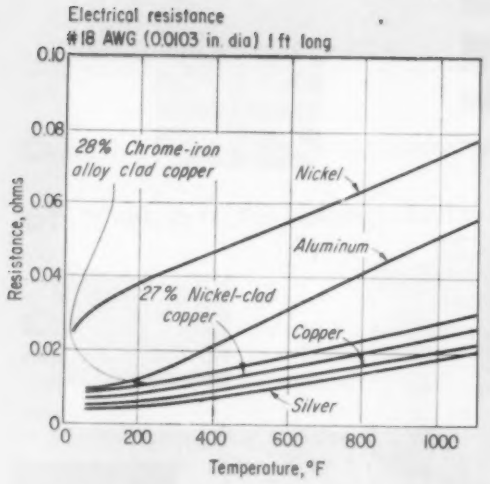
Permanent magnets made of Alnico (Types V, VI and VII) have a Curie point of about 1600 F, but are normally used at 1000 F or less because they undergo change of metallurgical structure at about 1100 F and some margin must be left for stabilizing.

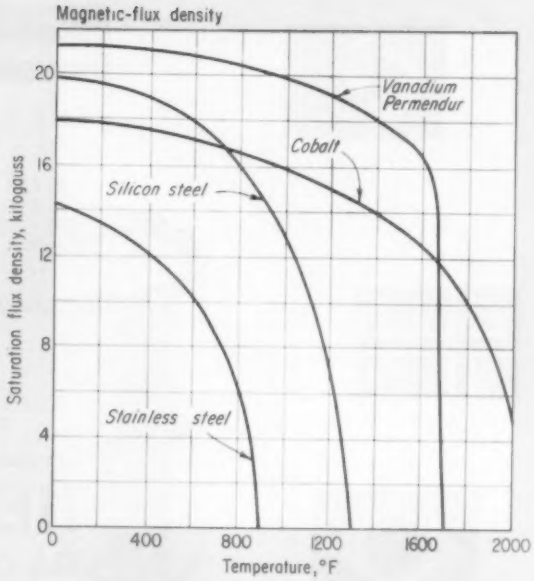
Rectifiers are an essential part of many magnetic-amplifier circuits, and may have to operate in the same hot environment. Gallium arsenide and gallium phosphide semiconductors are being developed for temperatures to 1500 F. Silicon carbide diodes are already available for 900-F operation.

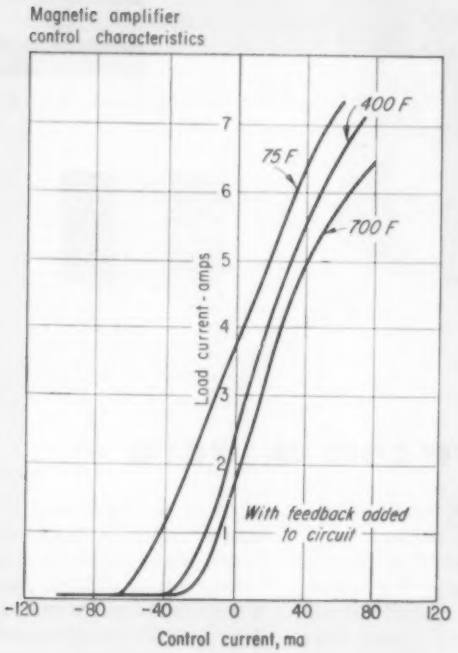
Motors and Solenoids

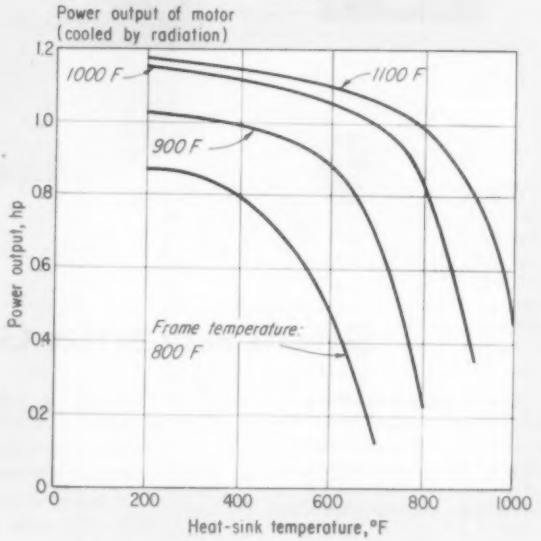
Preliminary work is being done in the development of a ½-hp lightweight induction motor to operate at 1000 F, cooled by direct radiation. Running on gas bearings, it will operate at 24,000 rpm from 115-v 3-phase 400-cycle power.

It is here where the efficiency of cooling by radiation pays off with its increase that theoretically corresponds to the 4th power of absolute temperature. But be sure the equipment can operate through the whole temperature range, because startup is usually cold. In particular,









allow for differential thermal expansion—it may change airgap or bearing clearances.

Ac and dc solenoids have been tested at 1000 F for hundreds of hours without evidence of deterioration. And some have been operated without loss of performance even though bombarded with nuclear radiation.

Magnet-wire insulation for high temperatures can be of "served" glass type for larger sizes and special films for the smaller. Such special insulation materials have been developed recently under government contracts, and will be forthcoming from wire manufacturers.

EDITOR'S NOTE: This previous article describes a solenoid built to operate at 500 F:

Hot Solenoid, Jan 6 '58, p 61—Fiberglass insulation lets rotary solenoid operate 300,000 times in 48 hr at 500 F.

Tips on dissipating heat by radiation and convection are given in these articles:

When Air Is the Coolant, Feb 16 '59, p 54—Step-by-step procedure calculates transfer of heat from aircooled part.

Radiation Characteristics of Metals, Sep '53, p 205—Compares emissivities of metals such as stainless steel and titanium for various surface conditions.

COMING SOON: an article on how to use emissivity in design to control or limit temperature of the part.

Wherever in the world your industrial machinery operates...

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Other outstanding Shell Industrial Lubricants available world-wide

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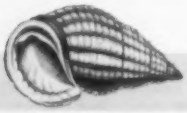
- **Shell Dromus Oils** – soluble cutting oils for high-production metalworking
- **Shell Macoma Oils** – for extreme pressure industrial gear lubrication
- **Shell Voluta Oils** – for high-speed quenching with maximum stability



AN INTERESTING FACT!
Every Shell Branded Industrial Lubricant is named for a sea shell. Shown here is the Alvania beanii.

Around the world, Shell Alvania Grease is available—under the same brand name and providing the same outstanding lubrication. This is assurance that your customers abroad will enjoy the same performance from your equipment that domestic customers rely upon.

Alvania® Grease offers these performance-proved advantages: (1) It provides safe lubrication at both high and low temperatures. (2) It won't wash out even in locations where water splashing can't be avoided. (3) It has built-in protection against rust and pitting of anti-friction bearings. And because this *one* multi-purpose grease is specially designed to satisfy as much as 90% of industrial grease needs, less servicing time is required; inventory costs are less; and there is less risk of misapplication.

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SHELL

AID FOR STOP-WATCH WATCHERS:

Decimal Equivalents of Seconds and Minutes

Like shillings and pence, seconds and minutes are awkward to work with arithmetically. Tables I and II convert seconds and minutes to their more easily manipulated decimal equivalents.

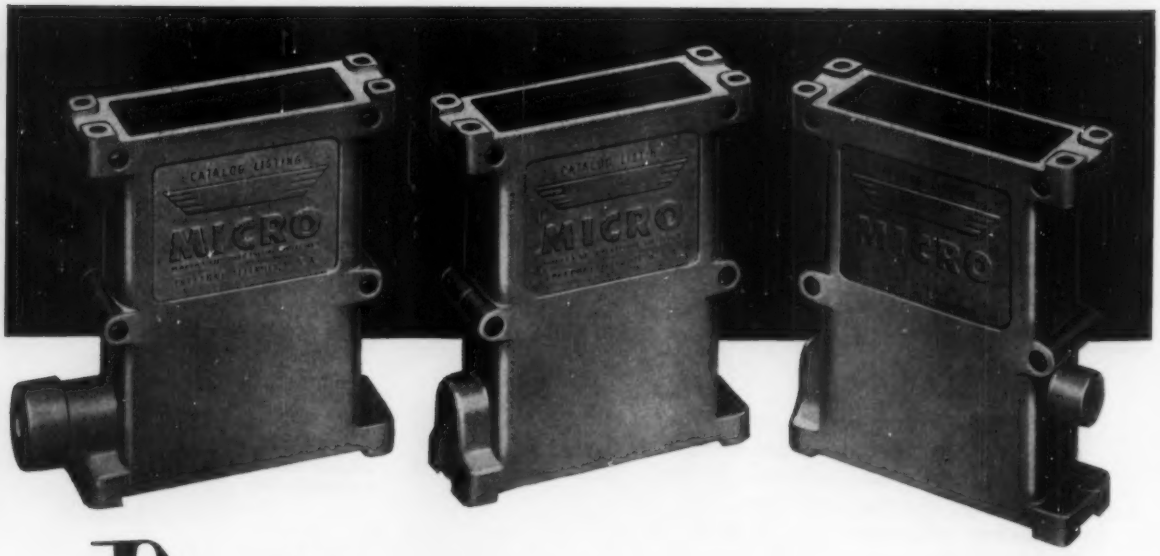
Another annoyance is using two stop watches that read in different units. Some watches divide a minute into seconds; others divide minutes into hundredths. Table III compares the two scales.

O K GRADE, *senior methods engineer*
Machlett Laboratories Inc
Springdale, Conn

TABLE I—Decimal Equivalents of Seconds

Seconds	Minutes	Hours
1	0.0167	0.000277
2	0.0333	0.000555
3	0.0500	0.000833
4	0.0667	0.001111
5	0.0833	0.001388
6	0.1000	0.001666
7	0.1167	0.001944
8	0.1333	0.002222
9	0.1500	0.002500
10	0.1667	0.002777
11	0.1834	0.003055
12	0.2000	0.003333
13	0.2167	0.003611
14	0.2333	0.003888
15	0.2500	0.004166
16	0.2667	0.004444
17	0.2833	0.004722
18	0.3000	0.005000
19	0.3167	0.005277
20	0.3333	0.005555
21	0.3500	0.005833
22	0.3667	0.006111
23	0.3833	0.006388
24	0.4000	0.006666
25	0.4167	0.006944
26	0.4333	0.007222
27	0.4500	0.007500
28	0.4667	0.007777
29	0.4833	0.008055
30	0.5000	0.008333
31	0.5167	0.008611
32	0.5333	0.008888
33	0.5500	0.009166
34	0.5667	0.009444
35	0.5833	0.009722
36	0.6000	0.010000
37	0.6167	0.010277
38	0.6333	0.010555
39	0.6500	0.010833
40	0.6667	0.011111
41	0.6833	0.011388
42	0.7000	0.011666
43	0.7167	0.011944
44	0.7333	0.012222
45	0.7500	0.012500
46	0.7667	0.012777
47	0.7833	0.013055
48	0.8000	0.013333
49	0.8166	0.013611
50	0.8333	0.013888
51	0.8500	0.014166
52	0.8667	0.014444
53	0.8833	0.014722
54	0.9000	0.015000
55	0.9167	0.015277
56	0.9333	0.015555
57	0.9500	0.015833
58	0.9667	0.016111
59	0.9833	0.016388
60	1.0000	0.016666

continued, page 61



Designing FOR MULTIPLE PRODUCTS IN SINGLE TOOLING WITH MADISON-KIPP

ZINC AND ALUMINUM DIE CASTINGS

The three castings illustrated are made in the same die. Provision for the changeable die parts must be included in the original die design. Expert die making is also involved, but the end results of this type of pre-planning represent substantial savings in many instances.

Madison-Kipp is skilled and seasoned in die casting mechanics and invites your inquiries for cooperative effort.

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TABLE II—Decimal Equivalents of Minutes

Minutes	Hours
1	0.0167
2	0.0333
3	0.0500
4	0.0667
5	0.0833
6	0.1000
7	0.1167
8	0.1333
9	0.1500
10	0.1667
11	0.1834
12	0.2000
13	0.2167
14	0.2333
15	0.2500
16	0.2667
17	0.2833
18	0.3000
19	0.3167
20	0.3333
21	0.3500
22	0.3667
23	0.3833
24	0.4000
25	0.4167
26	0.4333
27	0.4500
28	0.4667
29	0.4833
30	0.5000

Minutes	Hours
31	0.5167
32	0.5333
33	0.5500
34	0.5667
35	0.5833
36	0.6000
37	0.6167
38	0.6333
39	0.6500
40	0.6667
41	0.6833
42	0.7000
43	0.7167
44	0.7333
45	0.7500
46	0.7667
47	0.7833
48	0.8000
49	0.8166
50	0.8333
51	0.8500
52	0.8667
53	0.8833
54	0.9000
55	0.9167
56	0.9333
57	0.9500
58	0.9667
59	0.9833
60	1.0000

TABLE III—Comparison Between One-second Graduations and 1/100-minute Graduations

1/100 Minutes	Seconds
1	0.6
2	1.2
3	1.8
4	2.4
5	3.0
6	3.6
7	4.2
8	4.8
9	5.4
10	6.0
11	6.6
12	7.2
13	7.8
14	8.4
15	9.0
16	9.6
17	10.2
18	10.8
19	11.4
20	12.0
21	12.6
22	13.2
23	13.8
24	14.4
25	15.0

1/100 Minutes	Seconds
26	15.6
27	16.2
28	16.8
29	17.4
30	18.0
31	18.6
32	19.2
33	19.8
34	20.4
35	21.0
36	21.6
37	22.2
38	22.8
39	23.4
40	24.0
41	24.6
42	25.2
43	25.8
44	26.4
45	27.0
46	27.6
47	28.2
48	28.8
49	29.4
50	30.0

1/100 Minutes	Seconds
51	30.6
52	31.2
53	31.8
54	32.4
55	33.0
56	33.6
57	34.2
58	34.8
59	35.4
60	36.0
61	36.6
62	37.2
63	37.8
64	38.4
65	39.0
66	39.6
67	40.2
68	40.8
69	41.4
70	42.0
71	42.6
72	43.2
73	43.8
74	44.4
75	45.0

1/100 Minutes	Seconds
76	45.6
77	46.2
78	46.8
79	47.4
80	48.0
81	48.6
82	49.2
83	49.8
84	50.4
85	51.0
86	51.6
87	52.2
88	52.8
89	53.4
90	54.0
91	54.6
92	55.2
93	55.8
94	56.4
95	57.0
96	57.6
97	58.2
98	58.8
99	59.4
100	60.0

How SHAKEPROOF Protects Your Product's Reputation

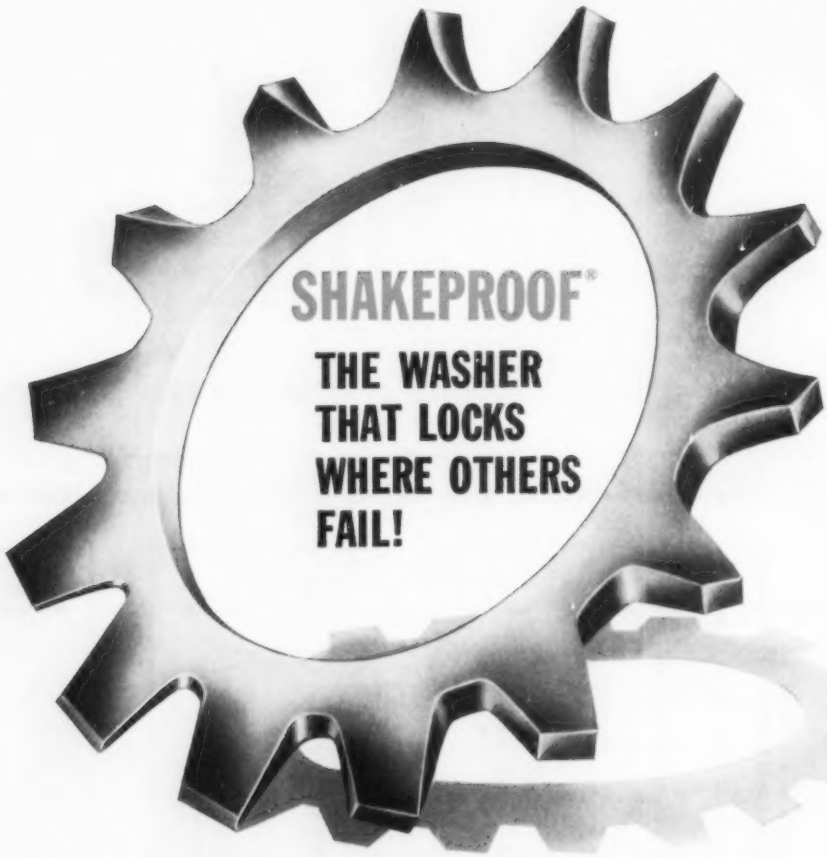
Here is the answer to one of industry's toughest problems . . . how to reduce costly inspection rejects and avoid customer complaints due to fastening failure.

Shakeproof engineers have gathered formidable evidence that only one washer locks . . . where others fail! Their findings, just published in the booklet offered at the right, prove that "weight and thickness" don't lock a fastener, and that "spring action" alone isn't locking action.

They have conducted tests with various types of washers commonly used for protection against failure caused by handling and operational vibration. Results show that only Shakeproof Lock Washers retained 100% relative locking efficiency.

Be sure to protect your product's performance and reputation with the one top-quality, top-performance lock washer . . . Specify SHAKEPROOF . . . the *original* toothed lock washer!

Send for this Free Booklet Today—it is filled with factual test data and actual case histories which show how you can be sure of quality at every step in the assembly of your product.



STANDARD SHAKEPROOF LOCK WASHERS INCLUDE:

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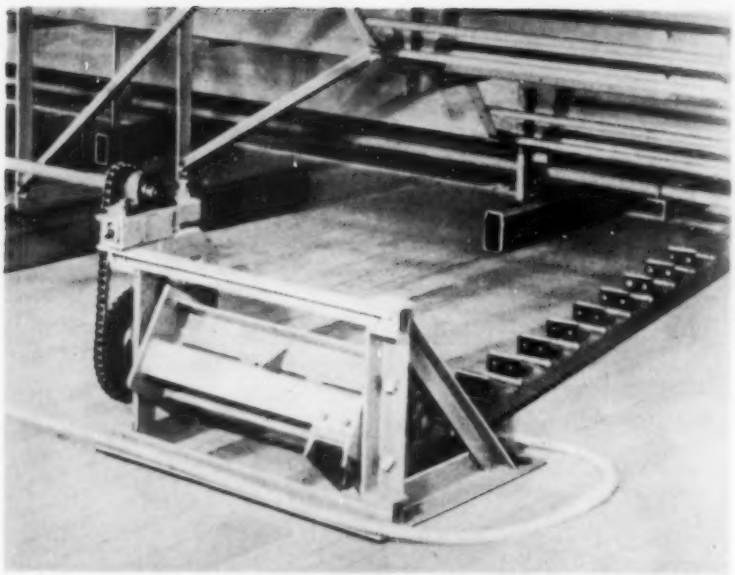
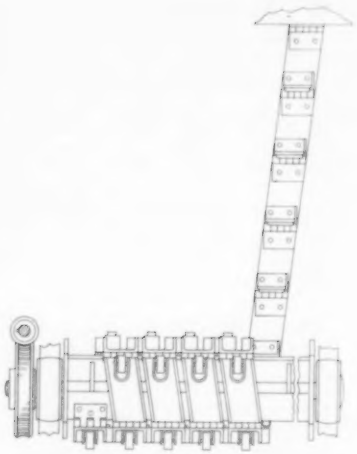
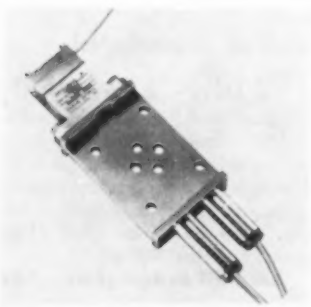
SIGNIFICANT COMPONENTS MATERIALS, PROCESSES





Power-operated folding column . . .
rolls in or out to form rigid column capable of pushing or pulling heavy loads linearly with steady force. When rolled in, it occupies only tiny percentage of extended size. (For example, standard unit that extends 45 ft is taken up into space about 2 ft sq). Column is formed of hinged links of steel that are wound helically around power-operated drum. Drum, formed of angle-shape structural members, resembles, in cross-section, a swastika on a stick. When equipped with a powering device, drum feeds out or withdraws column to transmit large forces. As it unrolls, column is completely rigid in three directions, but must roll out over flat surface to provide rigidity in fourth direction. Can be built to any size and load capacity, limited only by basic laws of mechanics that apply to rigidity of slender columns. Any material can be used. Unit is self-compensating for use in extreme heat and cold. Offers micrometer adjustment on front and overload torque protection. Applications for the self-contained device include actuating and positioning equipment in aircraft and missiles; positioning of nuclear elements; introducing equipment or materials into a furnace; mounting inside trucks to push out heavy pallets. Wayne Iron Works, 147 N Pembroke Ave, Wayne, Penna.

Circle 300 on Reader Service Card



Servovalve monitoring system
consists of three pressure transducers mounted on thin manifold block that fits between servovalve being monitored and hydraulic-system manifold. A 3000-psi differential transducer gives constant readout of pressure difference between two control ports of servovalve; 3000- and 300-psig transducers give constant indications of pressure at supply and return ports. Accuracy of system matches that of pressure transducers used. Typical nonlinearity and hysteresis combined, less than 0.25% of full scale; thermal zero and sensitivity drift each less than 0.015% of full scale F from −65 to 275 F; combined errors from all sources less than 0.5% of full scale. System has provision for shunt calibration and has miniature signal conditioning amplifiers with excitation sources. When used with amplifiers, system is excited by 28-v source ±3 v and will give 5-v output ±0.5% of full scale for telemetering systems. Delivery, 3 to 6 wk. Price varies from about $700 to $900. Standard Controls Inc, 1130 Poplar Pl, Seattle 44.

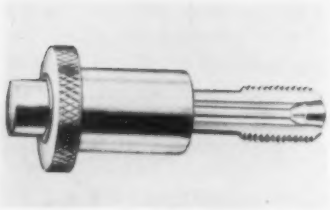
Circle 301 on Reader Service Card

Double-deck strain gage . . .
mounts on one side of structure being analyzed yet provides measurements for analysis that would normally require separate gages mounted on both sides of section. Foil resistance gages are embedded in plastic strip at controlled distances from each other and deform integrally with structure. Gage is attached with regular strain gage cement. Measurements of the two gages permit calculation of bending and axial strain components, since total strain distribution is linear throughout the sandwich. Temperature limits range from room temperature to 100 F. Available in 1¼, 1½, and 2 in. sizes for metal thicknesses of 0.020 to 0.040, 0.040 to 0.080, and 0.080 to 0.160 in., respectively. Priced under $15. From

continued on page 64

stock after Oct 1. Rosettes also available. **Instrument Div, Budd Co, Phoenixville, Penna.**

Circle 302 on Reader Service Card



Quick-disconnect bolts . . .

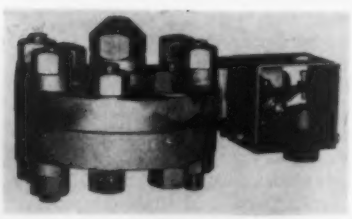
are engaged or disengaged by releasing or depressing a button that operates a spring-loaded mandrel. Mandrel maintains positive, locked-in contact between threads of tapped hole, or nut threads, with threads on quick-release bolt. Available in alloy or stainless steel in $\frac{5}{16}$-, $\frac{3}{8}$- and $\frac{1}{2}$-in. sizes. Current delivery, 6 to 8 wk. **Avdel Inc, 210 S Victory Blvd, Burbank, Calif.**

Circle 303 on Reader Service Card

10.6-in.-dia speed reducer . . .

is shaft-mounted unit, $4\frac{3}{4}$ in. wide, said to be capable of single-, two- and three-speed reductions for $\frac{1}{4}$ to 12-hp range. All reductions are within dimensions of pulley, inside housing, providing reductions from 2.52:1 to 76:1. Can be supplied as plain speed reducer, or with friction clutch or built as two-speed reducer with both speeds clutch-controlled. Speeds can be in same direction or opposite directions. Can also be furnished with adaptor rings and torque member for many types of electric and air brakes and clutches for remote control. Delivery on most sizes, 3 days. **Hart Reduction Pulley Co, 1116 Adams St, Waukesha, Wis.**

Circle 304 on Reader Service Card



Differential-level pilot valve

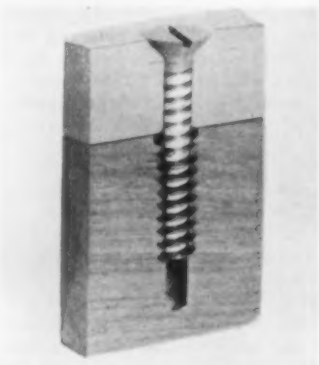
is said not to be affected by variable system pressures. Operates on difference between two columns of liquid, usually between a constant-reference head and a variable head. As level rises in variable column, valve opens and releases air pressure from top of diaphragm motor valve, allowing discharge of liquid from variable column. When level in this column falls to predetermined level, valve closes, and cycle repeats. Principle can also be utilized with steam trap to operate over wide range of pressures compared with average trap that operates over narrow range. Valve is $438. Shipment, 4 wk. **Besler Corp, 4053 Harlan St, Emeryville, Oakland 8, Calif.**

Circle 305 on Reader Service Card

Small door-retaining spring . . .

is installed on inside of equipment, invisible from the outside. Consists of tiny steel spring and cam device that hold door firmly in both open and closed positions. Requires little inside space for clearance. Location of cam and spring is interchangeable. Each assembly weighs 0.014 lb. **Southco Div, South Chester Corp, Industrial Highway, Lester, Penna.**

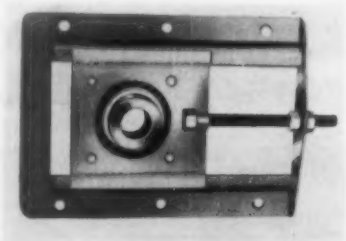
Circle 306 on Reader Service Card



Self-tapping wood fastener . . .

is reported to offer up to $2\frac{1}{2}$ times the holding power of standard fasteners. Insert fastener is, essentially, a tightly wound coil of wire, which is inserted into a hole drilled to accommodate a screw. Increased holding power is attributed to pitch, which is half that of standard machine screws, allowing it to leave relatively thick sections of wood between threads. Inserts are offered in standard sizes of $\frac{1}{4}$-10 and $\frac{5}{16}$-9. **Heli-Coil Corp, Shelter Rock Lane, Danbury, Conn.**

Circle 307 on Reader Service Card



Light-duty takeup-bearing unit

incorporates prelubricated stamped bearings, laminated neoprene felt seals. Available with or without frames in shaft sizes from $\frac{5}{8}$ to 1 in. **Roberts Mfg Inc, Salina, Kans.**

Circle 308 on Reader Service Card

Transmissions with electromagnetic clutches . . .

permit speed changes and reversing under power, without interrupting power source. Available with two to eight speeds, capacities from 52 to 750 ft-lb and ratio selections up to 10:1. Speed changes can be controlled manually or automatically. **Western Mfg Co, 3400 Scotten Ave, Detroit 10.**

Circle 309 on Reader Service Card

Front-access light bank . . .

provides visual decimal display in projection-type, one-plane presentation. For standard relay-rack mounting. In addition to mounting of lamp bank behind front plate for front-access servicing, unit also offers integral cables. Operates at ambient temperatures of −58 to 158 F. Unit is $3\frac{1}{2}$ x 19 x 6 in. deep. Available in models of two to eight digits. **Datex Corp, 1307 S Myrtle Ave, Monrovia, Calif.**

Circle 310 on Reader Service Card

As-welded, unannealed stainless pipe . . .

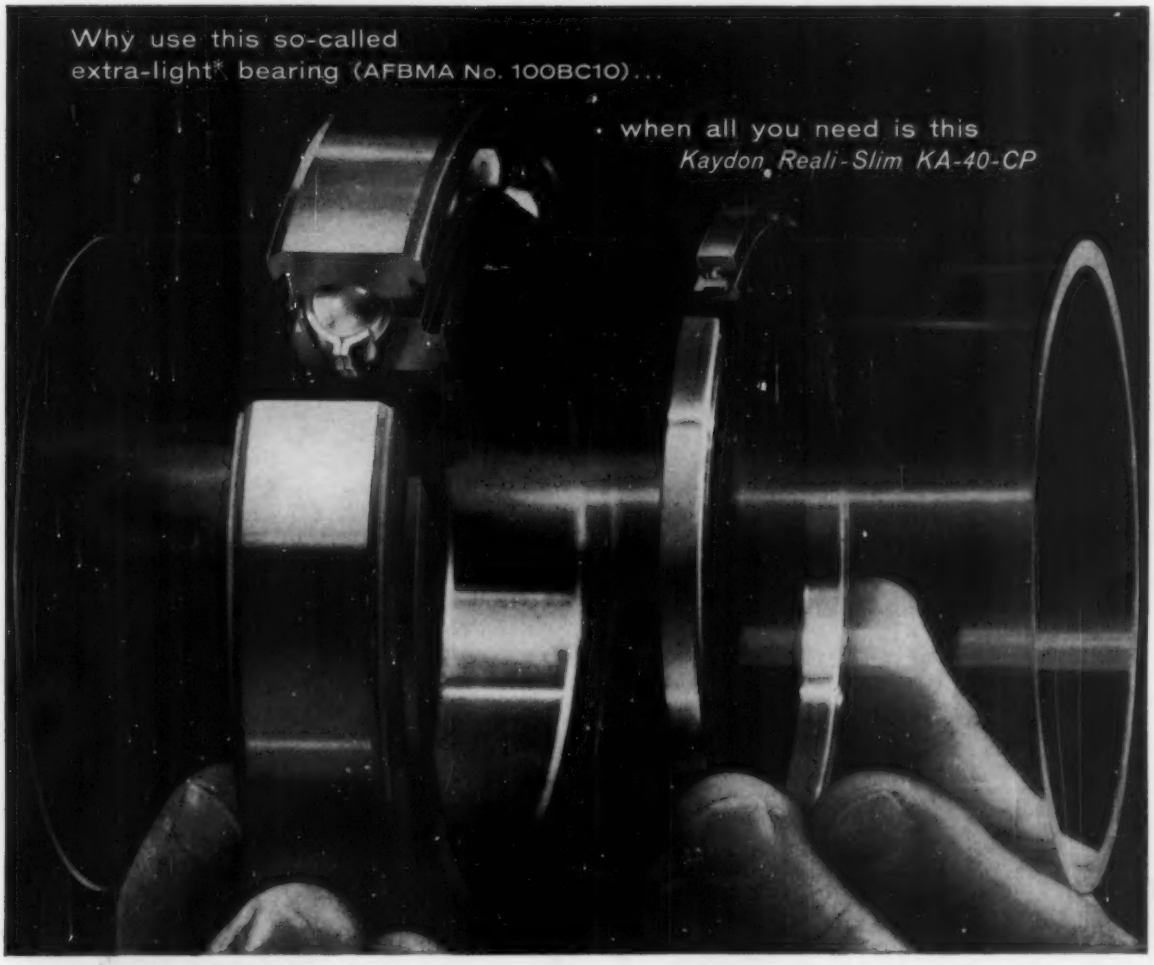
is now available in types 304L and 316L and is manufactured to ASTM specification A-312. Produced in schedule 5, 10 and 40 pipe sizes. Stainless pipe is intended for use in systems where noncontamination of product is of primary importance. **Standard Tube Co, 24400 Plymouth Rd, Detroit 39.**

Circle 311 on Reader Service Card

Spring-loaded union check valve . . .

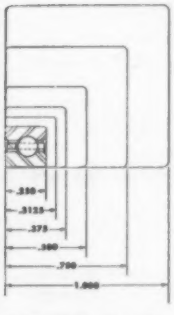
offers full-size waterway opening, said to permit 15% more volume of passable liquid than other comparable valves.

continued on page 66



News from Kaydon!

Reali-Slim bearings "off the shelf" ...prices slashed up to 76%



*Five of the six series of Type "CP" Reali-Slim bearings are smaller in cross section than the AFBMA standard "extra-light" series bearing shown above.

Up to 85% lighter, up to 70% narrower than the lightest of the "extra-lights"

More than 80% of all present standard "extra-light" series bearing installations never require the full capacity of the bearing.

Kaydon now trims this expensive bearing excess! Kaydon Type "CP" Reali-Slim bearings match proper size, weight and capacity to specified shaft sizes. Overcapacity need no longer hamstring your product designs.

Here's why! In Kaydon's new Type "CP" Reali-Slim bearings (world's thinnest), width and cross section *remain the same* for all bearing sizes in any one series.

Example: each of the 15 sizes from 4" to 12" bore in the Reali-Slim KA series has only ¼" width and cross section. Result: new opportunity to save on cost, size, and weight . . . in bearings and adjacent components.

Availability? Now off-the-shelf in 90 sizes with Conrad deep-groove, ball-radial construction . . . and new bronze one-piece snap-over separator in 4" to 12" bore — ¼" to 1" width and cross section. Kaydon's volume production cuts prices as much as 76%, depending on size. Write for free, fact-filled "CP" bearing bulletin — with prices!

THE KAYDON ENGINEERING CORP.
MUSKEGON • MICHIGAN

All types of ball and roller bearings — 4" inside diameter to 178" outside diameter . . . Taper Roller Roller Thrust • Roller Radial • Needle Roller • Ball Radial • Ball Thrust • Four-Point Contact Bearings

K-160

HIGH RESISTANCE TO STRONG OXIDIZING ACIDS

TECHNICAL MEMO ON LINEAR COMPOUNDS
7661-70 and 7662-70

. . . outstanding material for O-Rings

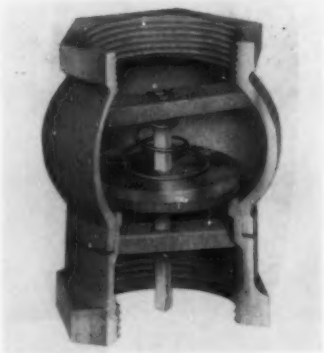
- 7661-70 has good resistance to red fuming nitric and other strong oxidizing acids.
- 7662-70 has low compression set properties.
- Both compounds highly resistant to most petroleum fuels and oils.
- Effective sealing from −20°F to +300°F.

MATERIALS COMPATIBLE WITH THESE COMPOUNDS

Acetylene Tetrabromide • Air • Aliphatic Solvents • Amyl Alcohol • Arochlor 1242 • Arochlor 1248 • ASTM No. 1 Oil • ASTM No. 3 Oil • Cellulube 1000 • Crude Oil • Ethyl Alcohol • Greases • Hydrochloric Acid • Isobutyl Alcohol • Iso-octane • JP-3 Fuel • JP-4 Fuel • JP-5 Fuel • MIL-F-25558A • MIL-L-2105 • MIL-L-9000 • MIL-L-15016 • MIL-L-15017 • MIL-L-17331 • MIL-O-5606 • MLO-8200 • Motor Oil • Nitric Acid • Propyl Alcohol • Pydraul A-200 • Pydraul F-9 • Shell Iris 902 • Shell Tellus • Sulfuric Acid • Tall Oil • Titanium Tetrachloride • Transformer Oil

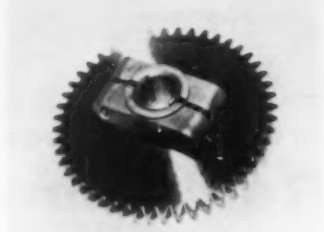
For complete technical data—including list of incompatible fluids—request Bulletin 56709-1. Linear, Inc., State Road and Levick St., Philadelphia 35, Pa.

PERFECTION IN RUBBER
LINEAR
LINEAR, INC. STATE ROAD & LEVICK ST. PHILA. 35, PA



Spherical body is reported to allow large-sized solids to pass through valve. Smaller grains of sand and water mineral deposits pass through valve without retention in valve body. Union connection allows inspection and disk replacement without removing from line. Triangular tapered guide bar is said to prevent buildup of foreign matter and to be automatically self-seating. Can be used in any position. Now available in 1-, 1¼-, 1½- and 2-in. sizes; list priced at $4.25, $5.50, $7 and $10.60, respectively. **Typhoon Products, 131 San Lorenzo, Coral Gables, Fla.**

Circle 312 on Reader Service Card

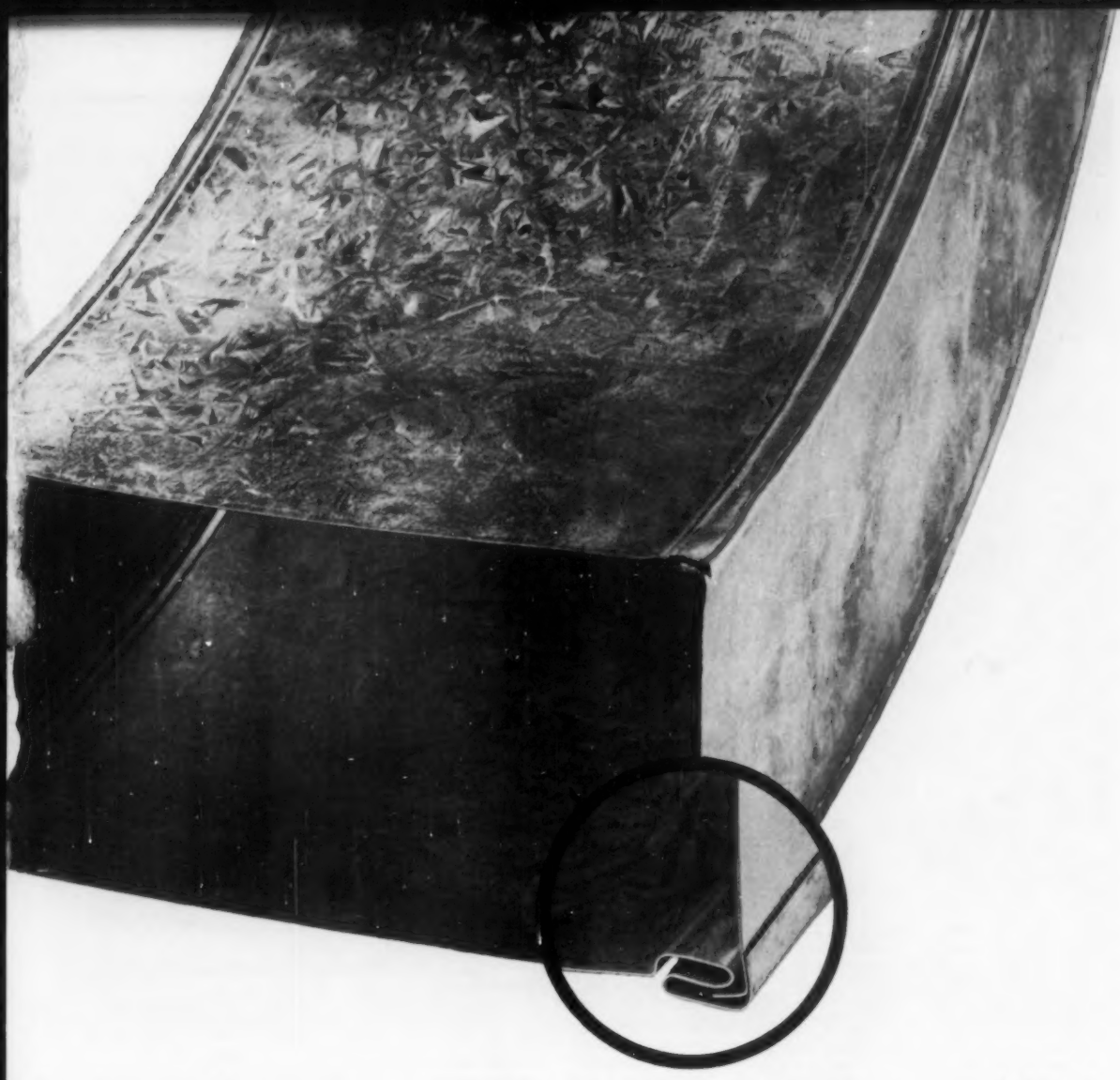


Adjustable hub clamps . . . are dynamically balanced for use with high-speed precision motors, synchros, resolvers and instrument shafts. Clamps are available from stock in ⅛, 5/16 and ¼ in. shaft sizes. Said to conform to MIL specifications. Clamps are made from heat-treated 416 stainless steel. **Pic Design Corp, 477 Atlantic Ave, East Rockaway, NY.**

Circle 313 on Reader Service Card

Pumping of fluids . . . containing hard particles, such as coolants, is provided by positive displacement pump utilizing abrasion-resistant helical screw rotor turning in stator. Pump drive can be integral part of machine tool drive or separate from, but automatically started with, machine drive. Can be mounted horizontally or vertically. Available with 110-v, single-phase and 220/440-v, three-phase, 50/60 cps motors. Various mod-

continued on page 68



Lock seaming ceases to be a problem when you use Weirkote Zinc-Coated Steel. This modern continuous-process tightly bonded zinc-coated steel won't peel, chip or flake. Work it to the limits of the steel base itself and the zinc coating remains intact assuring you of the complete corrosion protection that only zinc can give. A Weirton representative will be happy to supply more complete information on Weirkote—another fine product of the Weirton Steel Company, Weirton, West Virginia.

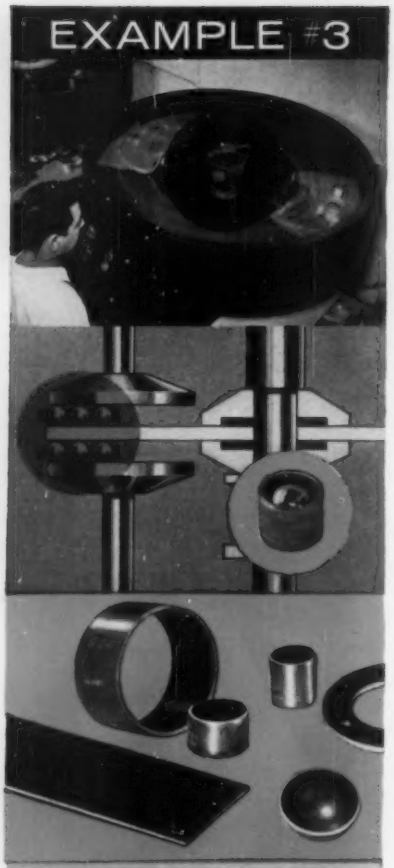
Look for the STEELMARK on the products you buy; place it on the products you sell.

WEIRTON STEEL
Weirton, West Virginia

Weirton Steel is a division of **NATIONAL STEEL CORPORATION**

Weirkote will also be available in 1961 from National's Midwest Steel Division, Portage, Indiana.

CIRCLE 67 ON READER SERVICE CARD



DU bushings (bottom) partially surround each steel ball in the new "Rouverol" ball-galaxy principle variable speed drive (center), capable of operating up to 8000 rpm. This permits dramatic advance in centrifuge equipment (top) for more accurate missile and aircraft component operational G-force testing. Design illustrates use of DU bushings in lubricated ball bearing where dry operational capability pays off in hard-to-lubricate areas.

DU* DRY BEARINGS

Solve Another Problem

"Our 909 Variable-Speed Transmission is a high-torque, ball-disc friction drive† which utilizes two clusters of steel balls for the transfer elements instead of the more conventional single-ball configuration. Many bearing materials were tested before a satisfactory cluster cage assembly was evolved. The successful design incorporated DU bushings which are partially swaged around each ball for increased bearing area. In addition to an extremely low coefficient of friction, the bushings transfer heat away from critical areas much more efficiently than other materials tested. Problems concerning wear, and tolerance of foreign particles have virtually disappeared."

R. E. Brown

Vice President—Engineering

GENISCO, INC.

DU metal is an ideal bearing material for many applications. It withstands much higher velocities, runs much cooler at lower speeds than other unlubricated bearings . . . has a compressive strength of 51,000 p.s.i. DU metal is applied without the need for temperature-limiting adhesives . . . will withstand from −328°F to +536°F.

GARLOCK

Apply DU dry bearings to appliances, automobiles, aircraft, farm and industrial machinery, office equipment. Standard bushings and thrust washers available for ¼" to 2" shafts; strip available for special fabrication. Write for engineering catalog DU-458. Special Products Dept., Garlock Inc., P.O. Box 612, Camden 1, New Jersey.

*Trademark, Glacier Metal Company Ltd.

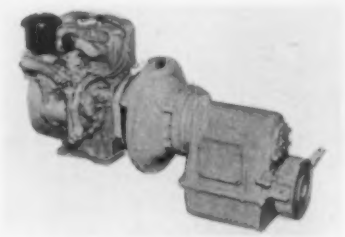
†Manufactured under license agreement from W.S. Rouverol, University of California at Berkely

els are rated, at 1725 rpm, for flows from 4 gpm at 30 psi to 25 gpm at 50 psi; pumping to atmosphere, max flow ranges from 6 to 40 gpm. Motorless units can be powered by drive shaft or separate motor serving dual function. Associated Engineers Inc, PO Box 1628, Springfield, Mass.

Circle 314 on Reader Service Card

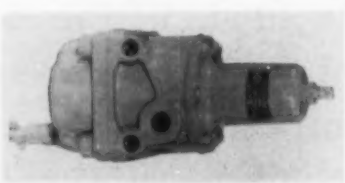
Sensitive temperature control is said to meet MIL-S-5272A with AN connector and industrial specifications where small size and light weight are necessary. Has OD of ¼ in.; length below thread of 1½ in.; and over-all weight of 2 oz. Low standard setting tolerance is about ±5 F, depending on balance of electrical circuit involved. Contact rating is 1 amp, 115 v ac. Can be hermetically sealed. Scaico Controls Inc, 210 Taylor St, Riverside, NJ.

Circle 315 on Reader Service Card



Hydraulic torque-converter . . . drive is three-element, single-stage unit for use in powered equipment. Connects directly to liquid and air cooled engines in 18 to 35 hp range and has gear-type charging pump. Oil-cooled, multiple-disk shift clutches facilitate shifting from forward to reverse, with common lubricant serving both transmission and converter. Prime-Mover Co, Muscatine, Iowa.

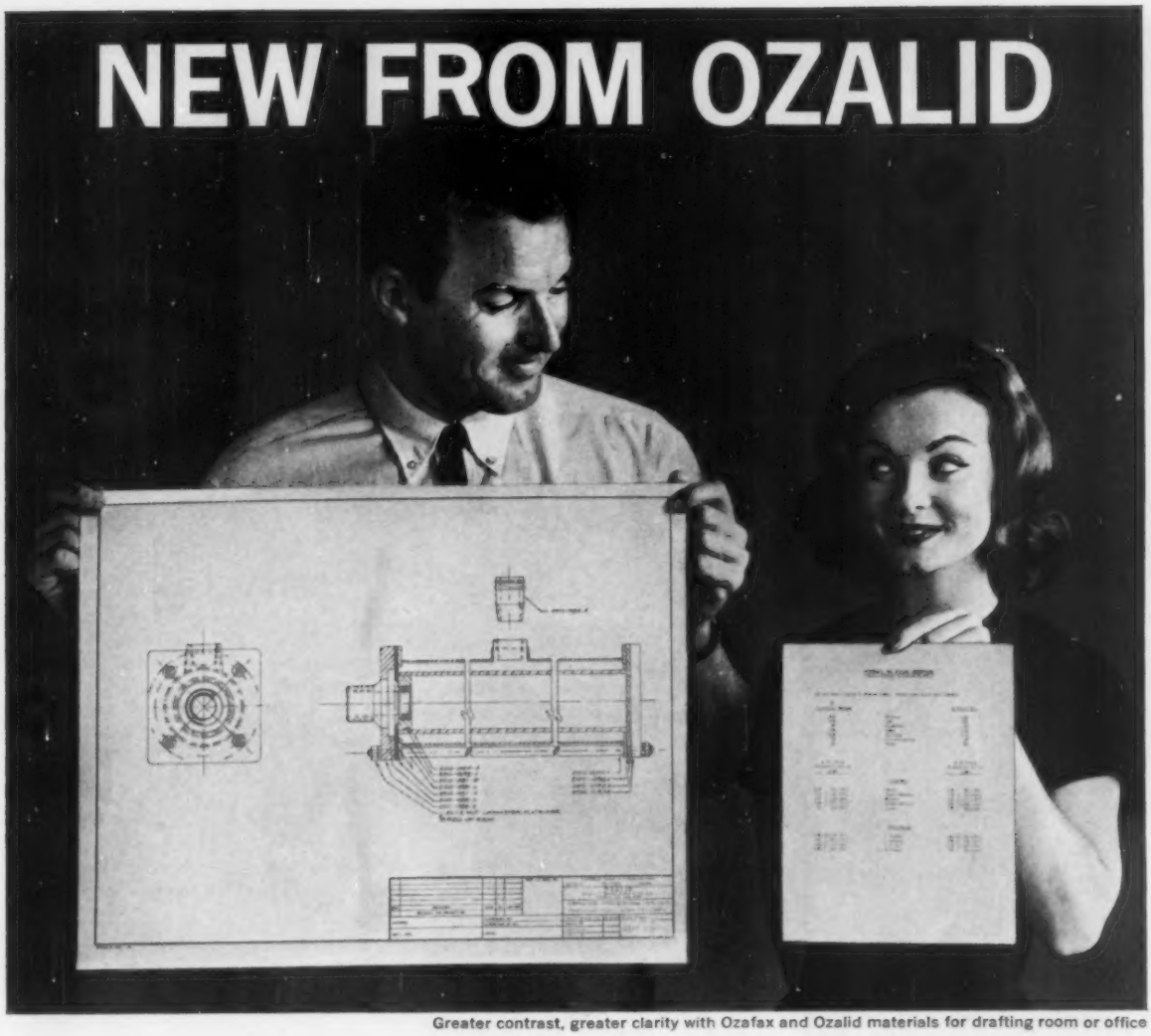
Circle 316 on Reader Service Card



Lightweight filter-regulator . . . is applicable to control systems where clean air or gas is needed. Especially suited for single unit hookups and production equipment, paint spray units, air chucks, gas drives, instruments and air cylinders. Constructed of pressure die-cast aluminum, unit has max inlet pres-

continued on page 70

NEW FROM OZALID



Greater contrast, greater clarity with Ozafax and Ozalid materials for drafting room or office

New Ozafax semi-dry papers and developers now bring Ozalid quality to every Diazo Copy Machine

From Ozalid—the nation's leader in dry diazo materials for more than a quarter of a century—comes Ozafax, the newest line of top quality semi-dry copy materials. Regardless of the make machine you own, you can now look to Ozalid as a new source of supply for all your diazo copying needs, and look to Ozafax for . . .

Better Contrast! A new, advanced diazo coating formulation fastens a sharp black image against a clean white background. On the shelf or after processing, the bright white appearance of Ozafax papers lasts.

Broader Line of Colors! Ozafax papers are available in 6 appealing colors for more flexible coding. No wider variety of tinted stocks anywhere.

From every angle—speed, quality or simplified ordering and inventory—Ozafax improves your reproduction operation. Call your local Ozalid representative or mail coupon today.

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A Division of General Aniline & Film Corp.

SEND TODAY FOR FURTHER INFORMATION
Ozalid, Dept. DD-9, Johnson City, New York

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- ☐ Please send information explaining the new Ozafax semi-dry diazo materials.
- ☐ Please have representative call.

Name_____

Firm_____

Phone_____

Address_____

City_____ Zone_____

State_____

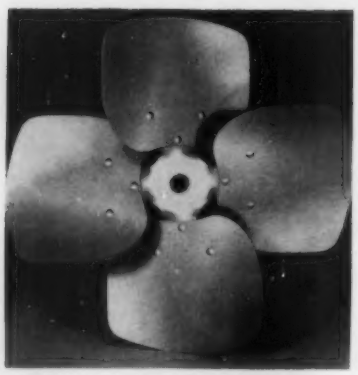
sure of 250 psi and outlet pressure ranges of 0-5, 5-35 and 35-100 psi. General construction and performance is the same as instrument regulator, with exception of body, which has been modified with filter bowl. Bowl contains replaceable filter cartridge and ⅛-in. drain valve at bottom of bowl. Available without internal relief valves. **Meter and Valve Div, Rockwell Mfg Co, 400 N Lexington Ave, Pittsburgh 8.**

Circle 317 on Reader Service Card

Valve for high-vacuum service

reported to operate with vacuums down to 10^{-8} mm mercury, has been added to line of differential pressure diaphragm control manifold valves for use in automatic control circuits. Incorporates same features as standard line, including only one moving part. Available in stainless steel and brass, with ports accommodating tube sizes from ⅛ to ½ in. in either flare or flareless fitting. Same range of sizes is offered for pipe taps. Priced from $19. **Frankel Engineering Laboratories Inc, 207 S 5th St, Reading, Penna.**

Circle 318 on Reader Service Card



High-output axial fans . . .

are said to be efficient over unusually wide range of free-air and pressure applications. Now available in 8, 10, 12, 14, 16, 18 and 20 in. dia. **Air Impeller Div, Torrington Mfg Co, Torrington, Conn.**

Circle 319 on Reader Service Card

Programable digital comparator . . .

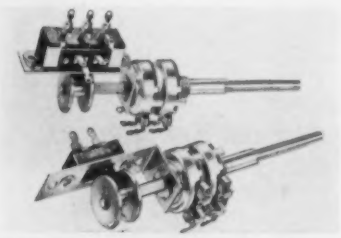
which utilizes solid-state circuitry throughout, is said to be capable of comparing measurement numbers at rates to 100,000 per sec. Accepts digital information from analog-to-digital converter, for example, and compares it with preset high and low tolerance limits. It then gives correct answers in terms of Go, No-Go-Hi, or No-Go-Low. Temporary storage for programed and measured information is provided by three registers. Appropriate limits for each measurement are transformed to high- and low-limit registers from tape reader or other programing device. Visual output indicators are provided and electrical output signals are available to operate printer or control circuitry. Comparator circuitry consists of etched-card modules that fit into standard 19-in. rack-mounted chassis with 5¼ in. panel height. Power requirements, including indicators, are 1 amp at 15 v dc. Price, depending on accessories, is about $2000. Immediately available. **Leach Corp, Compton, Calif.**

Circle 320 on Reader Service Card

High-current thyratron . . .

is quick-heating industrial thyratron for control applications involving inductive loads. It is inert-gas-filled to give quick starting and constant characteristics within ambient temperature limits of −67 to 167 F. The 6.4 amp, 1000-v peak forward and 1250-v peak inverse tube has high commutation factor, 135 v/μsec X A/μsec. **National Electronics Inc, Geneva, Ill.**

Circle 321 on Reader Service Card



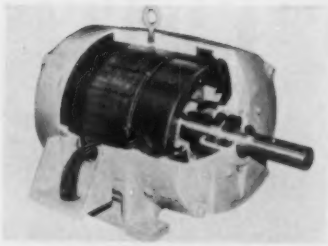
Slide-switch variable resistors

with ratings up to 6 amp, 125 v ac, are based on ½-w composition variable resistor, 1⅛ in. dia, with resistances from 200 ohm to 10 megohm, any taper. Available in positive or spring return styles, SPST to 4PDT. ½, 1, 3 and 6 amp ratings can be supplied. Available at 60 to 70¢ each, depending on switching arrangements and quantity. **Centralab, Div of Globe-Union Inc, 900 E Keefe Ave, Milwaukee 1.**

Circle 322 on Reader Service Card

Encapsulated motors . . .

are three- or two-phase ac squirrel-cage units, rated 1 through 125 hp. Epoxy compound, applied under vacuum to surround each wire in slots and at coil ends to produce solid, void-free mass, is said to provide winding protection of enclosed motors at 10 to 30% lower cost, depending on motor size. Available in NEMA designs A, B, C and D for 1, 2, 3 or 4



speed constant or variable torque operation, all standard voltages and frequencies. **Howell Electric Motors Co, 16313 W Seven Mile Rd, Detroit 35.**

Circle 323 on Reader Service Card

Electrical reset relay . . .

with mechanical latch has clear plastic cover, 12-pin plug and matching heavy-duty socket for industrial control panels. Consists of 219 frame plus latching frame. Rigid metal structure provides exact positioning of the two interfering armatures. This achieves high contact reliability throughout a min life of 10 million operations. Contacts are rated 10 amp at 115 v ac. All are operated by the same armature, eliminating overlapping contact closures. Available with DPDT, TPDT, and with two normally-open and two normally-closed contacts. 3¾ in. x 2 21/32 in x 27/32 in. deep. **Struthers-Dunn Inc, Pitman, NJ.**

Circle 324 on Reader Service Card

Industrial control relay . . .

is said to require up to 70% less panel space than conventional relays, 5½ sq in. for relay of 2 to 8 poles and up to 48 can be mounted per linear foot. Rated at 6 amp, 300 v max, unit is fixed circuit device with provisions for 8 independent poles. Also available in 2, 3, 4 or 6 poles in any combination of normally open or normally closed contacts. Bifurcated (split-saddle) contacts provide four current paths instead of single current path found in standard designs. **Cutler-Hammer, 296 N 12 St, Milwaukee.**

Circle 325 on Reader Service Card

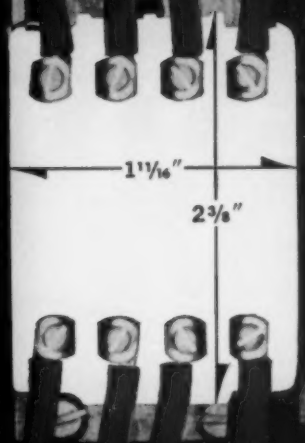
Dc output transducers . . .

are available in two models with input ranges of ±60° and ±30°. Both accept standard size 15 servo mountings. Designed for 400-cps, they are capable of operating at frequencies between 300 and 3000 cps with modified input voltage. In each model, magnetic transducer element is followed by demodulator circuit to provide dc output. This circuit is said to eliminate diode threshold problems, resulting in very sharp null with excellent

continued on page 74

CIRCLE 71 ON READER SERVICE CARD→

NEW MACHINE TOOL RELAY
cuts panel space



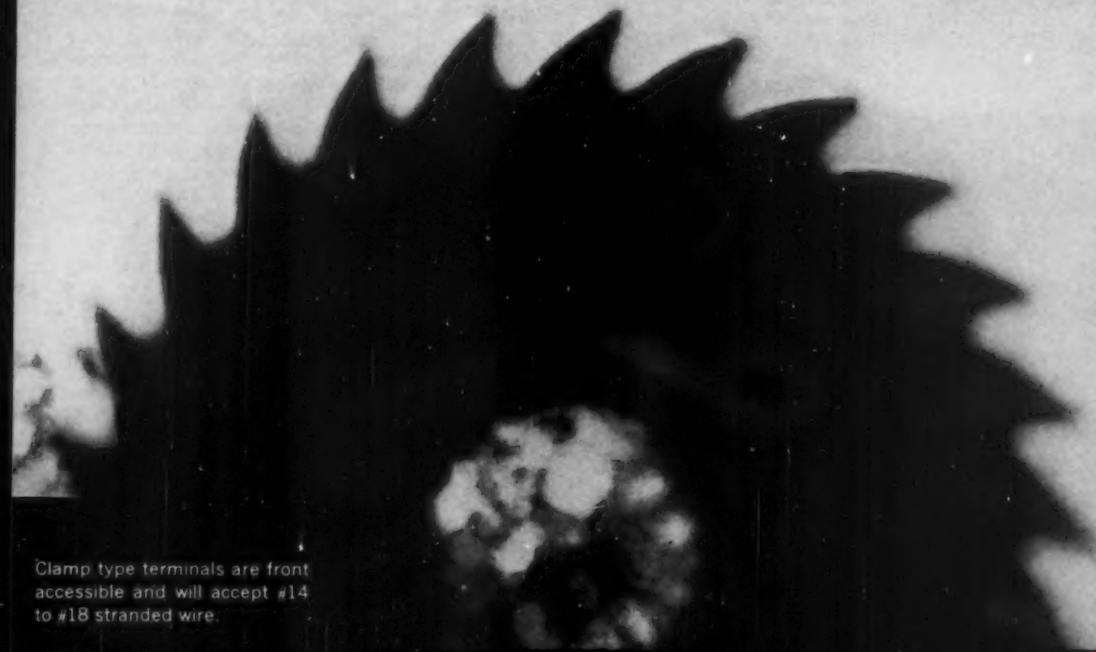
Actual size photo of machine tool panel

new machine tool relay cuts panel space 50%, reduces installed cost over 20%

ACTUAL SIZE

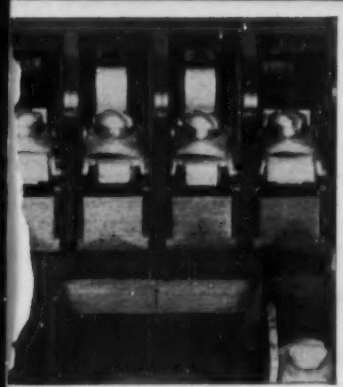
Machine tool relay is rated 6 amps, 300 volts a-c, from 2 to 8 poles in 2 basic frames. Relays can be butted against each other to save space.

Here's the new Westinghouse relay that cuts the control panel space requirements as much as 50%. Specifically designed for use on automated machine tools, this relay is smaller than any other similar unit available. Relays can be butted against each other in banks. What's more, both 4 and 8 pole frames have the same mounting dimensions, occupy the same panel area, and can be mounted adjacent to each other without additional electrical clearances. ■ Wiring a panel is easier, too. Relay terminals are all readily front accessible. Each of these clamp type connections has a wire stop . . . installation is faster and costs less. You actually save more than 20% over outdated relays. ■ This new relay has load rating of 6 amps, 300 volts a-c—found by experience to be ideal for most of the machine tools now being designed. ■ Want more information? Contact your nearest Westinghouse representative or write: Westinghouse Electric Corporation, Standard Control Division, Beaver, Pa. Remember: You can be sure if it's Westinghouse.



Clamp type terminals are front accessible and will accept #14 to #18 stranded wire.

J-30318



Westinghouse

How United States Testing Company helps

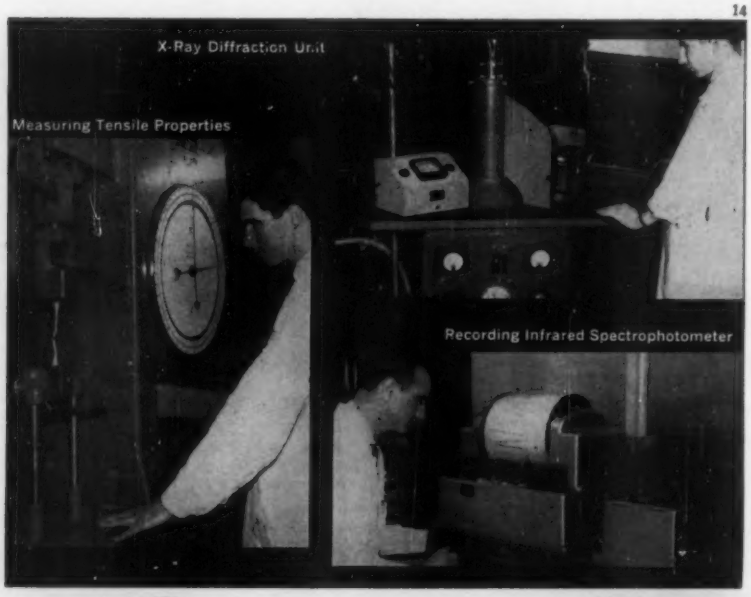
STOP TROUBLE BEFORE IT STARTS

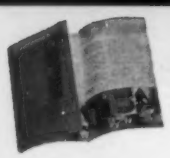
Spotting "bugs" in new products and eliminating them before marketing... that's how United States Testing Company saves clients thousands of dollars and priceless good will. Take the case of the new movie camera ready for the mass market... our test film went through without trouble, until a special spliced section jammed the sprockets and stripped a gear.

We examined the mechanism piece by piece and traced the fault to a structural defect in a key member. Our report to the client included end-use specifications for the defective part and a simple slip clutch design to prevent future gear failures.

Knowing how to induce failure in the laboratory, and prevent trouble in the field, calls for trained evaluation engineers... engineers who know sound corrective design, too. Why not apply this know-how to your new product. Write or phone for details. No obligation.

14





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linearity about the null point and absolute zero output at the null point. Transfer sensitivities are 0.35 v rms/° and 0.7 v rms/°, respectively. **Arnoux Corp, 11924 W Washington Blvd, Los Angeles 66.**

Circle 326 on Reader Service Card

Subminiature dc relay . . .

weighs 37/100 oz and has sensitivity of 35 milliw. SPDT relay is reported to have passed 6-cps, 508,500-cycle test without visible signs of wear or pitting; 115 v ac at 250 ma was said to be passed by contacts without arc suppression. Dimensions are 0.687 x 0.406 x 0.812 in. Offers excellent contact-wiping action; connections in single plane; single screw (2-56 x ¼) mounting. Units are available in 5000-, 1250-, 500-, 100-, and 50-ohm coil resistances, or to specifications. **W S Deans Co, 8512 E Gardendale, Downey, Calif.**

Circle 327 on Reader Service Card

TPDT slide switch . . .

is for switching applications in audio systems, electronic measuring devices, home appliances and industrial controls. Integral in one frame, with one actuating knob, switch is rated at 3 amp, 125 v ac-dc. To facilitate assembly in end products, all terminals are in common plane. All terminals and contacts are silver-plated, and standard units feature "short" terminals, with nominal 0.575 in. dimension from mounting surface to tip of terminal. Requires less than 0.6 cu in. **Continental-Wirt Electronics Corp, 26 W Queen Lane, Philadelphia 44.**

Circle 328 on Reader Service Card

Vane axial blower motor . . .

is reported to operate without diminshed performance even in very severe environments. Design features include speed of 22,300 rpm, low noise, high efficiency, full-load torque of 2.33 oz-ft. Open-ventilated, ¾ hp, 200-v, 400-cps, three-phase motor conforms to applicable portions of MIL-M-7969, MIL-S-7742, MIL-E-5272, MIL-E-4970, MPD2063, and MPD-

continued on page 75

154. Weighs 3 lb 10 oz. Hertner Electric Co, Sub of Kearfott Div of General Precision Inc, Little Falls, NJ.

Circle 329 on Reader Service Card

Standard 2-in. blowers . . .

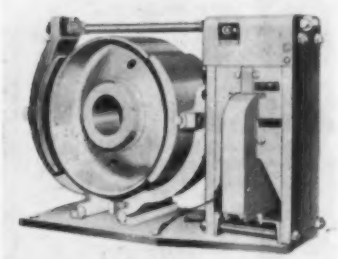
are guaranteed for 2000-hr life at 22,000 rpm. Motor is removable unit and can be slipped out of blower. All parts are also interchangeable and available as spares. 400-cps motors of blowers are constructed of stainless steel and bearings are larger in diameter than normally found in motors of this size. Offered in range of models in both ac and dc motors. Dean and Benson Research, Div of Benson Mfg Co, Kansas City 27, Mo.

Circle 330 on Reader Service Card

Fhp electric brakes, clutches . . .

are said to provide higher torque per unit size than other comparable units and to cost less. Now being produced in two sizes: 0.875 in. dia with 2 in.-lb torque, and 1.725 in. dia with 10 in.-lb torque. Brakes and clutches are supplied as 28 v or 90 v standard. Control units are available. Haydon Div of General Time Corp, 245 E Elm St, Torrington, Conn.

Circle 331 on Reader Service Card



30-in. mill brake . . .

is for heavier requirements of frame 620, 622 and 624 mill motors. Rated at 9000 ft-lb ½-hr series wound or 1-hr shunt wound, 6750 ft-lb continuous-duty shunt wound and 6000 ft-lb 1-hr series wound. Other brakes in line are 8, 10, 13, 16, 19 and 23-in. units. Cutler-Hammer, 296 N 12th St, Milwaukee.

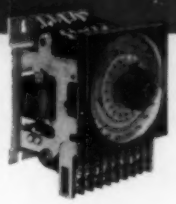
Circle 332 on Reader Service Card

100%-solids epoxy adhesive

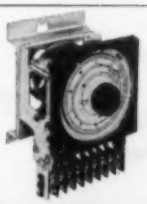
is internally catalyzed formulation said to adhere to most materials better than most two-part epoxy adhesives. Aluminum-to-aluminum bond offers shear strength exceeding 3000 psi; bonds to glass are beyond measurement (glass itself delaminates on test). Bond is reported to be stable from —94 to 257 F. Since adhesive is moderately

continued on page 77

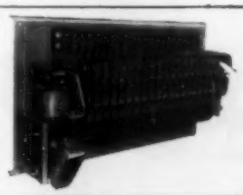
Count Control
COMPONENTS
FOR AUTOMATING INDUSTRIAL PROCESSES
featuring
adjustable count
automatic reset
10 ampere switches



model HZ4
MICROFLEX RESET COUNTER
Use to control an operation for a preset number of counts. Has spring reset to "0." Dial ranges 19, 400 and 1,000 counts.
Ask for bulletin 720.



model HZ200
ADD-SUBTRACT COUNTER
Add-Subtract counter — operates from ADD pulses which trip switch at maximum limit — and SUBTRACT pulses which trip switch at "0" limit.
Ask for bulletin 740.



model MT
STEP SWITCH
Use for sequence control from pulses — 19 contacts — 60 cycle coil-break out cam lugs.
Ask for bulletin 780.

model HZ6
MICROFLEX REVOLUTION COUNTER
Use to control an operation as a function of mechanical movement — drive shaft can be mechanically connected to machine, spindle, conveyor, etc.
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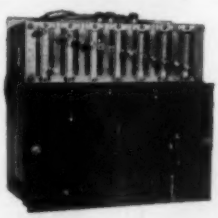

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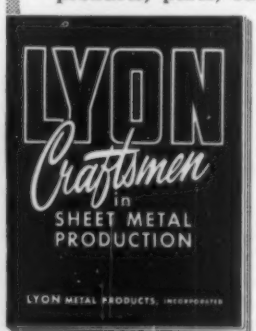

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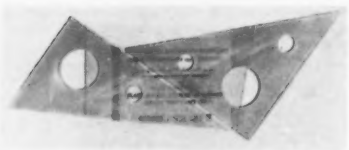

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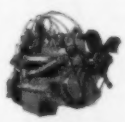

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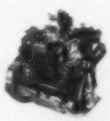

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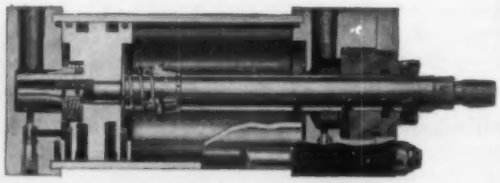

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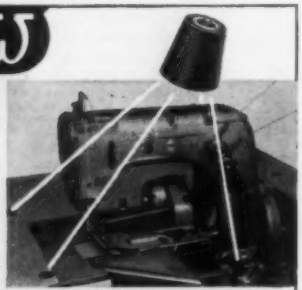

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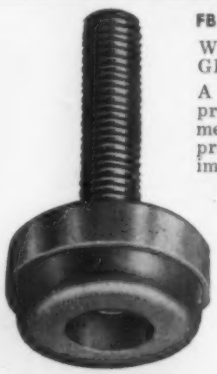

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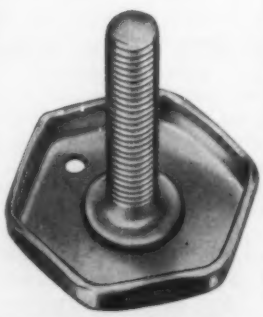

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DESIGN LITERATURE

Engineering Mathematics

BLAKEY and HUTTON. Philosophical Library Inc, 15 E 40th St, NYC. 6 x 8½, 603 pp. $10.

Covering most of the mathematics needed for a degree in engineering, this book should prove useful to the engineer as a reference text.

It is based on Dr Blakey's well-known "University Mathematics." The more-theoretical chapters have been removed and replaced by chapters on Numerical Solution of Equations, Statistics, Relaxation Methods, and Laplace Transformations.

Introduction to Linear Differential Equations

E G C POOLE. Dover Publications Inc, 180 Varick St, New York 14. 5 x 8, 217 pp. $1.65.

Study of differential equations began with Newton and Leibnitz, and most of the elementary methods of solution were discovered in the course of the eighteenth century. Where a problem could not be solved in finite terms, expansions in power-series were tentatively employed by Newton. But the theory was not placed on a satisfactory logical basis until about a century ago, when Cauchy distinguished between analytical and non-analytic systems, and constructed rigorous existence theorems appropriate to each type.

Ordinary linear equations, with which this book deals, have always attracted particular attention by their numerous practical applications. While some branches arose out of physical problems, others were created by the progress of the theory of functions and of the theory of groups.

This book is based on lectures to senior undergraduates at Oxford, and is designed for students and engineers who have already taken an elementary course of differential equations, but have not yet specialized.

A Guide to US Indexing & Abstracting Services . . . in Science and Technology

Report No. 101. National Federation of Science Abstracting and Indexing Services, 301 E Capitol St, Washington 3, DC. 8½ x 11, 79 pp. $2.

Although this guide is the result of a preliminary survey and has the inherent drawbacks of data collection by questionnaire, it is well indexed and will help to fulfill an information need which has long been unsatisfied. A satisfactory up-to-date compilation of the indexing, abstracting and reviewing services of scientific interest existing in this country should prove to be a tool of considerable value to the scientific literature searcher.

ABSTRACTS FROM THE LITERATURE

Evaluation of Basic Strength Data of Materials

Discusses data on physical and mechanical properties normally obtained with standard test equipment and procedures and relates it to actual significance and meaning in terms of the real strength requirements of design applications. Considered are tensile strength, yielded point, stress-strain, fatigue strength.

"Evaluation of Physical Strength of Materials." Mechanical World and Engineering Review, Aug, '60, 31 King St W, 3, Manchester, England.

Vibration Isolation

This is the second of a three-part article. Part one discussed balancing of rotating machinery (June '59). Part three will probably not appear until 1961.

This part includes data on vibration frequency; determining theoretical isolation efficiency and other selection factors; spring-type mounts, rubber isolators, inertia blocks, flexible connectors, structural damping; and other materials and processes.

"Vibration Isolation," Steve Elonka, Assoc Editor, Power, Aug '60, 330 W 42nd St, New York 36.

CATALOGS AND BULLETINS

To obtain copies of literature described below, circle corresponding number on postcard inside back cover.

ELECTRONIC COMPONENTS – Catalog FR-61-E, 32 pp. Specifications, photos, dimensional drawings and prices for each product. Covers plugs, jacks, adaptors, connectors, shielded jacks, cord-

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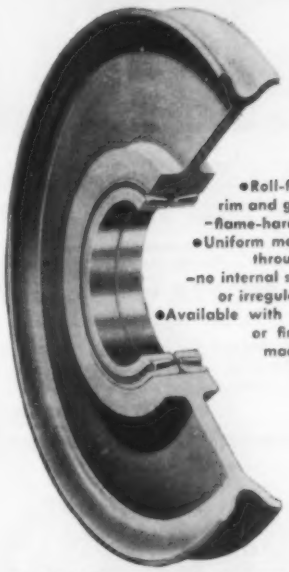

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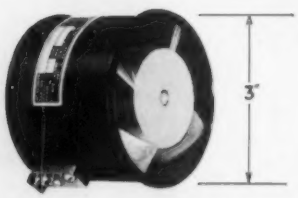

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VACUUM COATING AND EQUIPMENT—Bulletin 2-2, 28 pp. Describes and discusses vacuum-coating process and its applications, as well as specifications of coating units available. Consolidated Vacuum Corp, 1775 Mt Read Blvd, Rochester 3, NY.

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NUMERICAL CONTROL SYSTEM—Brochure, 8 pp. Describes numerical control system, which offers production accuracy up to 0.0002 on 40-in. work table.

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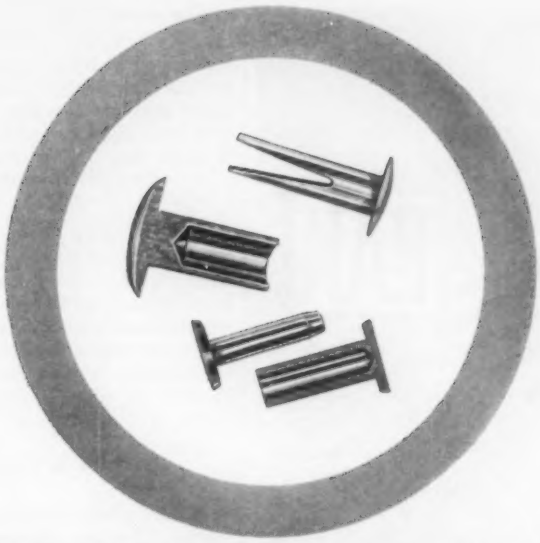

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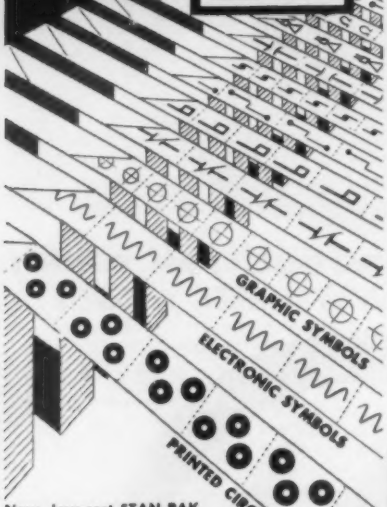

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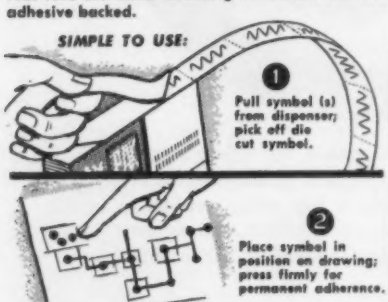
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MACHINE TOOL FOR AUTOMATIC ASSEMBLY–Catalog 602, 8 pp. Describes standard rotary-transfer machine that includes parts-placing motions at working area on dial. Dimensions and design information are given for standard cam-actuated work-station mechanisms. Presents case histories. Ferguson Machine Corp, 7818 Maplewood Industrial Ct, St Louis 17.
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ENGINEERING SERVICES–Brochure, 16 pp. Covers design and engineering services available to management and manufacturing. Modern Engineering Service Co, PO Box 1007, Berkley, Mich.
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HERMETICALLY SEALED ROTARY SWITCH–Bulletin D-460, 13 pp. Three sections illustrate 3072 standard designs, including dimensions, drawings, mountings, receptacles and wiring. Also contains control and performance data, environmental conditions and ratings. Ledex Inc, 123 Webster St, Dayton 2, Ohio.
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ANGULAR ACCELEROMETERS–Brochure, 6 pp. Features, applications and specifications of angular servo accelerometers. Donner Scientific Co, Concord, Calif.
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AC TO DC CONVERSION–Data sheet, 4 pp. Describes essential mode of operation and significant waveforms, both illustrated with diagrams. Adage Inc, 292 Main St, Cambridge 42, Mass.
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WELDING STUDS AND EQUIPMENT–Bulletins, 6 and 4 pp. Specifications of welding studs and stud-welding equipment, respectively. Equipment bulletin shows component parts of control unit and one-piece mechanism of shielded gun. Shielded Stud Welding Co, 2043 Gaylord St, Long Beach 13, Calif.
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900-F BOLTS AND LOCKNUTS–Bulletins EWB 926 (bolt) and FN 926 (nut), 4 pp each. Specifications of fasteners, which together comprise threaded joint of 200,000-psi ultimate tensile strength at 900 F. Bolt bulletin provides tabulated mechanical properties and plot of tension–tension-fatigue performance at

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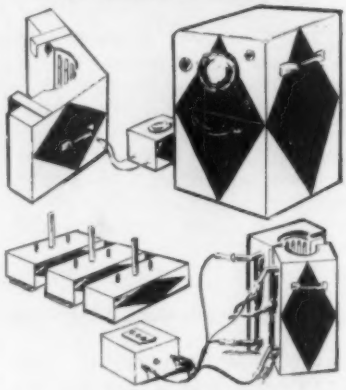

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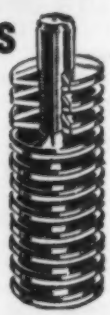

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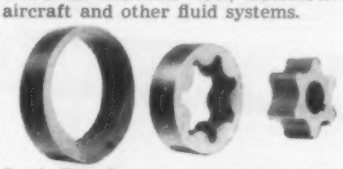

Fig. 1. Three Gerotor components permit pump to be incorporated as integral part of housing or frame of mechanism, eliminate need for purchase and mounting of separate, complete pump.

► A three-piece insert package makes this economical pump integration possible. Consisting of an inner and outer Gerotor and an eccentric locator-ring, the unit becomes a complete pump by simply boring the casting or frame of the mechanism to accommodate the locator ring O.D. and by providing porting. This design makes the main casting do double duty as the pump housing, thus eliminating a very considerable cost factor. A drive can be taken from any convenient shaft. A simple, positive-acting automatic reversing feature can be built in at little cost.

► The Gerotor is a form of internal gear pump consisting of only two moving parts: an inner toothed element and an outer, meshing toothed element. The inner element has one less tooth than the outer and the "missing tooth" provides a chamber to move the fluid from the inlet port to the outlet. (See Figure 2). Pump capacity is measured by the volume of the "missing tooth" multiplied by the number of driver teeth and RPM.

FIG. 2

► The designer thus has the advantage of several variables to secure a given capacity within his space limitations: *Gerotor diameter* — which governs the area of the pumping chamber — *Gerotor thickness* which, taken with area, determines chamber volume — *Gerotor RPM*, since this is a positive displacement pump. Thus, it is possible to vary the diameter, the length and the speed of the pump within certain overall limits to secure the wanted capacity.

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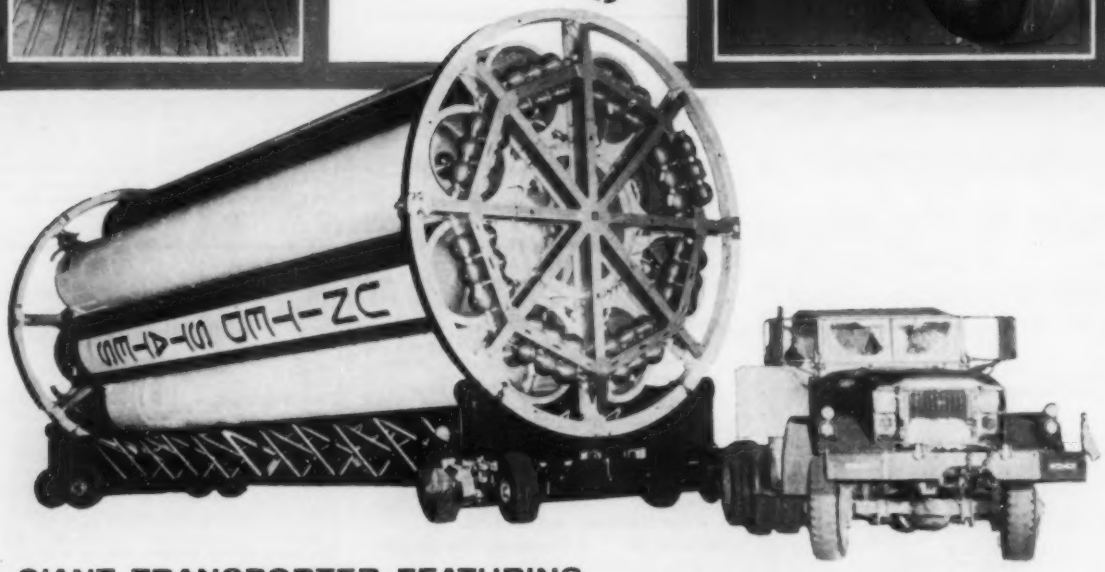

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15	35	55	75	95	115	135	155	175	195	215	235	255	275	295	315	330	345	360	375	390
16	36	56	76	96	116	136	156	176	196	216	236	256	276	296						
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18	38	58	78	98	118	138	158	178	198	218	238	258	278	298						
19	39	59	79	99	119	139	159	179	199	219	239	259	279	299						
20	40	60	80	100	120	140	160	180	200	220	240	260	280	300						

REPRINTS

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*MULTIPLE PRODUCT ADS	
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313—Adjustable Hub Clamps
316—Hydraulic Torque-converter
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323—Encapsulated Motors
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320—Programable Digital Comparator
321—High-current Thyratron
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314—Pumping of Fluids
317—Lightweight Filter-regulator
318—Valve for High Vacuum Service

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Name ..... Title .....

Street .....

City ..... Zone ..... State .....

Company ..... Major Product Manufactured .....

1	21	41	61	81	101	121	141	161	181	201	221	241	261	281	301	316	331	346	361	376
2	22	42	62	82	102	122	142	162	182	202	222	242	262	282	302	317	332	347	362	377
3	23	43	63	83	103	123	143	163	183	203	223	243	263	283	303	318	333	348	363	378
4	24	44	64	84	104	124	144	164	184	204	224	244	264	284	304	319	334	349	364	379
5	25	45	65	85	105	125	145	165	185	205	225	245	265	285	305	320	335	350	365	380
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7	27	47	67	87	107	127	147	167	187	207	227	247	267	287	307	322	337	352	367	382
8	28	48	68	88	108	128	148	168	188	208	228	248	268	288	308	323	338	353	368	383
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P54 P55 P56 P57 P58 P59 P60 P61 P62

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(please print or type)

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Street .....

City ..... Zone ..... State .....

Company ..... Major Product Manufactured .....

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*MULTIPLE Key No.	PRODUCT ADS Specific Product

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344—Ballbearing Slide Mechanisms, 16 pp, Jonathan Mfg Co.

FASTENING AND JOINING

346—Sockethead Capscrews, 9 pp, Standard Screw Co.
353—Welding Studs and Equipment, 100 pp, Shielded Stud Welding Co.
354—900-F Bolts and Locknuts, 8 pp, Standard Pressed Steel Co.

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340—Electronic Components, 32 pp, GC Electronics Co.
350—Hermetically Sealed Rotary Switch, 13 pp, Ledex Inc.
351—Angular Accelerometers, 6 pp, Donner Scientific Co.
352—Ac to Dc Conversion, 4 pp, Adage Inc.

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P-K Internal-Fin Coolers can be furnished insulated with Rock Cork laid in asphalt and covered with a heavy steel jacket. Illustration shows insulated cooler.

Revere helps fit the metal to the job

AND PATTERSON-KELLEY CUSTOMERS SAVE 3 WAYS

Because of its unique design, the Patterson-Kelley Freon Water Cooler shown at right above saves space, requires less Freon, while its reduced weight and size mean lower cost.

With the P-K Type FO Internal-Fin Freon 22 Water Cooler the installation can be designed for a shell 2 diameters less and 1 to 2 feet shorter than with conventional plain or bare tube coolers. This is made possible by the use of ¾" O.D. x .035" gauge Revere copper tube drawn over a Revere aluminum extruded fin as shown above. Serrated surface of the fin enhances refrigerant vaporization.

By making both the tube and the extruded fin, and assembling them in the same plant a tight contact between the two metals is assured, thus establishing maximum heat transfer. Once again Revere has helped fit the metal to the job, money was saved and a more efficient product produced.

Why not consult with Revere's Technical Advisory Service and take advantage of its extensive knowledge in "fitting the metal to the job." This Service has saved others money, why not you?

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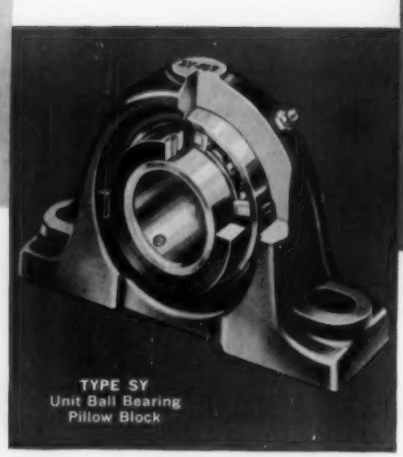
Ball or Spherical Roller
Bearing Pillow Block

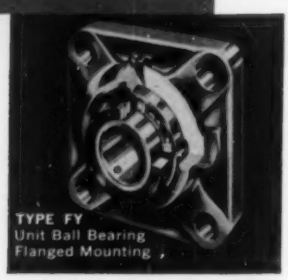
Can you get these "special" qualities in "standard" pillow blocks?

TYPE SDAF
Heavy-duty
Pillow Block



TYPE SY
Unit Ball Bearing
Pillow Block

TYPE SES
Unit Rubber-flex Ball
Bearing Pillow Block



TYPE FY
Unit Ball Bearing
Flanged Mounting

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They can—if they're the SKF pillow blocks, and flanged mounting, shown here. Type SAF, for example, comes equipped with low-friction ball or spherical roller bearings that are *inherently* self aligning. And these bearings are effectively protected by Triple-Seal rotating rings. Abrasives and corrosives can't get to them—oil or grease can't drip out.

Yet this is a standard SKF pillow block, that is competitively priced in spite of its combination of extra features. We make it for shaft sizes from ¾" to 10½", for mounting directly or with an adapter. A cast steel housing (SAFS) is available for heavy duty applications.

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